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EFFECTIVE KNOWLEDGE TRANSFER:
A TERMINOLOGICAL PERSPECTIVE

Dismantling the jargon barrier to
knowledge about computer security

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Doctor of Philosophy

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November 1993

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SUMMARY

The research presented in this thesis is concerned with the terminological problems that computer users experience when they try to formulate their knowledge needs and attempt to access information contained in computer manuals or on-line information systems in the process of building up their knowledge. This is the recognised but unresolved problem of communication between the specialist and the layman.

The initial hypothesis was that computer users, through their knowledge of language, have some prior knowledge of the subdomain of computing they are trying to come to terms with, and that language can be a facilitating mechanism, or an obstacle, in the development of that knowledge. Related to this is the supposition that users have a conceptual apparatus based on both theoretical knowledge and experience of the world, and of several domains of special reference related to the environment in which they operate.

The theoretical argument was developed by exploring the relationship between knowledge and language, and considering the efficacy of terms as agents of special subject knowledge representation. Having charted in a systematic way the territory of knowledge sources and types, we were able to establish that there are many aspects of knowledge which cannot be represented by terms. This submission is important, as it leads to the realisation that significant elements of knowledge are being disregarded in retrieval systems because they are normally expressed by language elements which do not enjoy the status of terms. Furthermore, we introduced the notion of "linguistic ease of retrieval" as a challenge to more conventional thinking which focuses on retrieval results.

The empirical part of the research was carried out by means of a survey whose primary aim was to collect user queries for analysis. The domain of computer security provided the focus for the data collection, and IBM's AS/400 computer system the documentation to which the queries could subsequently be related. Several global categories of knowledge needs were distilled from the query data, along with a catalogue of specific needs. A number of new principles were formulated for the creation of indexing tools.

Key words:- indexing, terminology, information retrieval, adult learning, knowledge representation

Dedicated to Shrimp and Kitty

Acknowledgements

I wish to thank and express my great respect for my supervisor, Professor Frank Knowles.

I am also grateful for the cooperation of the companies whose staff completed the questionnaire.

Finally, special thanks to my husband, Tony, for ensuring this work got done.

Contents

	Page
Introduction.....	10

Chapter I:

Comprehension in a terminological perspective

A.Theoretical reference points

1.Comprehension as knowledge-building.....	22
2.Terminological processing and knowledge transfer.....	23
3.The notion of effective transfer.....	29
4.The special role of terminology.....	31
5.Language and knowledge interrelated.....	32

B.Terminological investigation: aims, scope and methodology

1.Relating terminology and knowledge to readers and texts.....	33
2.Computer security as an important domain.	37
3.Sources of information on computer security.....	39
4.Primary data: users and texts.....	42
5.Evaluation criteria for effective transfer.....	43
6.Progression in stages in a multifaceted approach.....	44

Chapter II:

The nature of domain knowledge

A.Theories of knowledge

1.The inference/experience dichotomy.....	48
2.Sources of knowledge.....	50
3.An overview of knowledge types.....	53
4.Knowledge and language.....	58
5.Domain knowledge and specialisation.....	64

B.The organisation of knowledge

1.Units of knowledge.....	67
2.Domain knowledge representations.....	73
3.Lexical and terminological configurations.....	80

C.The specialised domain of computer security

1.Introductory remarks and definitions.....	86
2.Brief description of the domain.....	89
3.Characterisation in terms of knowledge types.....	93
4.Terminological and lexical characterisation.....	101

Chapter III:

Access to domain knowledge

A.Knowledge Transfer

1.Encoding of knowledge in texts.....	106
2.Textual communication of knowledge.....	110
3.Expression of knowledge needs.....	113
4.Access devices and reading skills.....	115
5.Knowledge assimilation.....	117
6.Computer security: knowledge transfer problems.....	118

B.Computer environments for knowledge transfer

1.Features of computer-assisted transfer...	121
2.Existing systems for knowledge transfer..	123
3.Searching on the IBM AS/400 system.....	128

Chapter IV:

Empirical study - the reader's perspective

A.Reader survey

1.Objectives and method.....	131
2.Reader profiles.....	134

B. Analysis of readers' needs

1. The language of queries

- a. Lexical and terminological analysis..... 135
- b. Intentional and rhetorical analysis..... 151
- c. Commentary on intentional and rhetorical analysis..... 169

2. Identification of knowledge types

- a. Knowledge need overview..... 174
- b. Dominant question forms and knowledge needs..... 178
- c. Source preferences and expectations..... 182

Chapter V:

Knowledge transfer - establishing a mapping

A. General characterisation of the security manual

- 1. Organisation and readership..... 185
- 2. Points of entry to the text..... 187

B. Summary of retrieval needs and retrieval problems

- 1. Evaluating the index..... 188
- 2. Knowledge needs and problems
 - a. General considerations..... 190
 - b. Content versus knowledge needs.... 192
- 3. Language needs and problems
 - a. Discussion of language needs..... 193
 - b. Terminological mapping problems
 - an illustration..... 197

Conclusions..... 200

Bibliography..... 210

Appendices

Appendix I:	Questionnaire.....	227
Appendix II:	Database of queries.....	228
Appendix III:	Concordance for "password*".....	238
Appendix IV:	Everyday formulations in users' queries.....	240

List of Figures and Tables

	Page
Figure 1:	
Examples of phrases from Bradburn's paper...	36
Figure 2:	
The development of knowledge.....	119
Figure 3:	
Knowledge need overview.....	176
Figure 4:	
Collocational pattern for "access" (n.).....	194
Table 1:	
Preferred sources.....	183
Table 2:	
Expected sources of answer.....	184

Introduction

When one considers the century's most significant developments with regard to the written word, the electronic encoding of texts has to be classed amongst the most portentous. One striking effect of the move to site texts - and indeed the act of writing itself - within a computer environment can be seen in the way that the latent open-ended nature of texts has been released, with greater emphasis and scope being given to the activities involved in their elaboration and decoding. As texts become more flexible and interactive, so one of the major barriers which has traditionally separated spoken and written discourse becomes eroded. We are witnessing a significant change in the correlation between texts and other communication media, as well as a redefinition of the relationship between writer, reader, and the intermediary of the written word.

It may be supposed that the medium which carries any text might colour one's perception of a text's essential nature, and a computer environment can indeed have this effect. Depending on one's perspective, a text can be: the 'end product' of a process of thought; an externalised fragment of personal or collective knowledge; an interplay of intentions, choices, linguistic resources, conventions, and rhetorical forms, shaped in the process of interaction between a writer and a reader. It is not only a means of self-expression (the predominant feature of childrens' writing; Bereiter & Scardamalia, 1982), a means of communication (Beaugrande, 1980), and a "constituent of the context in which it is produced" (Lyons,

1981), but for some, a "social construct" (Barrett, 1989), which, given the right online networked environment, can be a focus for an active, social construction of knowledge through collaborative writing. It has, of late, been the object of detailed investigation (eg. van Dijk & Petöfi, 1977; Aarts & Meijs, 1986), has become the focus of text theory and text linguistics (Dressler, 1978; Beaugrande & Dressler, 1980; Turney, 1988; Schröder, 1991), and has been given special attention in a number of text-centred disciplines, including advanced and specialist language teaching (Nuttall, 1982; Crombie, 1985; Swales, 1990) and information retrieval (Kay, 1985; van Vliet, 1986). It has come to be analysed as a source of knowledge for artificial intelligence applications: natural language understanding (Schank and Abelson, 1977; Wilensky, 1978), question-answering (Katz, 1988), automatic translation (Sadler, 1989), and knowledge bases (Moulin & Rousseau, 1990).

As many an individual elevated to a higher level of appreciation and prominence, the text has been attracting an entourage of aides, which would enhance it or act as 'stand-ins' for the text. This has resulted in methods and tools for concordancing (Hockey, 1980; Sinclair, 1991), planning (Friedman, 1987, 1989), indexing and abstracting (Sparck Jones, 1971; Borko, 1978; Sharp, 1989), editing and readability analysis (Kincaid et al., 1981; Macdonald et al., 1982; Kieras, 1989).

We can also observe a re-appraisal of the space occupied by text, as its woven fabric becomes stretchable, so that one can peer through windows into 'hyperspace', or follow threads to deeper layers (Barrett, 1988; McAleese, 1989). It is

susceptible to repeated alterations in the course of its creation, being revised iteratively on a graphological, syntactical, semantic or pragmatic level; it can be reconfigured to fit a chosen structure, or reformed to suit requirements on a screen or page.

Text-based on-line help is providing timely support for computer system users (Burrill, 1986; Duffy et al., 1989). In this way, on-line documentation, front-ended by an appropriate interface, conceals from view the forbidding volume of information which users may have to access, and can provide a body of reusable text to accelerate technical writing (Buchanan, 1990). On-line, interactive text is a source of expertise when experts are unavailable, and a source of document building blocks when time is lacking. It has the potential to help change the traditionally poor image of technical documentation.

Technical terminologies are, in parallel, undergoing significant advancements in respect of sheer growth in volume and diversity, and in the development of both the science of terminology and terminographical analysis methods (Wüster, 1974; Felber, 1984). In the course of the last twenty years, the task of analysing and representing relationships between specialised terms has been pursued with great precision and vigour. Terminology is making a contribution to knowledge based systems (Czap & Galinski, 1987; Czap & Nedobity, 1990; Schmitz, 1993), and is itself benefiting from tools and methods being developed in the field of knowledge engineering (Skuce & Meyer, 1990; Skuce, 1993). Recognising the importance of specialised terminologies in the development of science and

technology, and in the international exchange of information and documentation, standardisation bodies have intensified their efforts to establish and propagate standard terminology collections. This work has acquired even greater importance with the realisation that "the changeover from information bases to knowledge bases requires a new approach in information, making use of systematic terminologies" (Felber, 1984;1).

The proliferation of specialised vocabularies has drawn attention to the problem of communication between specialists and lay people. Mapping correspondences between the specialised terms used by members of a given trade or profession, and everyday language, has been the subject of study in areas as diverse as medicine and religion. An early example of this is the study made by Louis Marie Raymondis and Michel Le Guern in the seventies (Raymondis & Le Guern, 1976) of the language of penal law; environmental law is the subject of more recent studies (eg. Hansjörg, 1992). Today, the rapid growth of knowledge in all specialisms and its wider dissemination through computerised information systems affords this type of research even greater urgency. It calls for an adaptation of methodological approaches in the science and practice of terminology (Kukulska-Hulme, 1991). A more informal approach to the explanation of specialised vocabularies is also emerging (eg. computer dictionary by Williams & Cummings, 1993).

Progress in cognitive studies has yielded tentative descriptions of the complex cognitive processes of reading and writing, which go some way towards explaining the shape of their products: mental representations and written texts. Cognitive

psychologists have been exploring the psychology of language (Hörmann, 1977; Johnson-Laird, 1987), and process models of writing have emerged from psychological research (Hayes & Flower, 1980; Cooper & Matsuhashi, 1983; Bereiter & Scardamalia, 1987), as well as from investigations concerned with improving teaching methods (Calkins, 1980; Bridwell, Nancarrow & Ross, 1984). Reading and text comprehension, too, have become the object of research and modelling (Kintsch & van Dijk, 1978; Kieras, 1982; Reiser & Black, 1982). Some of these process models have been applied in the creation of computer software for the teaching of writing (Sharples, 1985, Friedman & Rand, 1989) and reading (eg. Geoffrion & Geoffrion, 1983).

One problem which writers and readers share alike is the logistical impossibility of satisfying the information needs of all eventual readers by the production of a single text. This basic problem of the explosive relationship of 'one to many' is waiting to be counterbalanced by a means of transforming a ubiquitous text into an interpretation by, or for, an individual. A computerised environment promises to be able to accommodate this need. The patient individual may be prepared to spend time interpreting texts, but overall the cost of the interpretation effort is running high. Training in new domains of knowledge, particularly related to new technologies, is continually on the increase, with high formal training costs and the scarcity of suitable manpower swaying decisions in favour of self-tutoring and on-the-job learning. In this scenario, specialist information which may be obtained from technical manuals increases in value, and manuals come to play a dual - reference and training - role. In

particular, knowledge about computers is no longer solely in the hands of specialists, as computer systems pervade all areas of life. Learning through reading becomes a critical faculty, and technical writing becomes a valued skill.

As writers' skills become augmented by new computerised tools which can analyse and provide assistance with their writing, so too readers' expectations of a higher standard of documentation are growing. If a higher standard is not delivered, or if a reader has personal misgivings about the precise meaning of parts of a text, there is still potentially the opportunity to look at an on-line manual through a comprehension tool which would aid and support individual learning and understanding. Admittedly, in the printed format, it has always been possible to let readers make their own decisions about which parts of a text to read, the sequence in which they are read, and the reference books or glossaries that are consulted. It is also true that alternative representations in the form of graphs, charts or illustrations have commonly been used by writers and editors to make good the deficiencies of text (eg. Hartley, 1985). What is new in an on-line environment, however, is the notion that the reader can query a text in a way which will make the text easier to understand. The emphasis here is on the fact that a *text needs a reader* in order that the communication process might be complete; appropriate computerised tools can make it possible for readers to assume conscious control of the way they 'complete' (i.e. interpret) texts, for example by providing improved indexing and searching aids. This allows us to surmise that interpretations will become more accurate.

What is of particular import here is the recognition of the inherent *imperfection of texts*, and at the same time the realisation that readers are not powerless when faced with this fact. If, as readers, we can unravel the obscurities which have been unwittingly twined with the thread of a text, we are better equipped to avoid misinterpretation. Computer-assisted reading can serve both readers (reading for comprehension) and writers (reading with a view to editing for a given readership).

The problems associated with texts are many. To begin with, a text must be seen in the context of other writings treating the same or similar subject; for example, a technical manual may be one of a series of manuals covering related aspects of the operation of a machine. In this sense, a given text is incomplete, and even if no other written source exists, there may be a body of personal knowledge and experience which is not easily captured by the written word. Furthermore, practical constraints in terms of available space may preclude a comprehensive treatment of a subject. Next, there is the writer's skill and knowledge, which may be limited, and the same applies to the reader's prior knowledge and reading skills. The relationship between the reader and the text is then a compromise, and necessarily imperfect. Finally, the words themselves are not just a means, but also potentially an obstacle, to textual communication. The success of communication depends greatly on writers' and readers' mutual understanding of terms.

Readers have traditionally looked to dictionaries or glossaries to clarify the meanings of terms encountered in texts. While recognising the fact

that electronic reference tools can provide an unprecedented wealth of information in a computerised reading or writing environment, it is important to consider how they are best constructed and employed. Text processing makes it possible for dictionary information to be complemented or replaced by data gleaned from texts. For a given comprehension problem, the most relevant information might be that relating to previous and subsequent uses of a term in that text. This is where the concept of a lexical reading and writing aid becomes applicable (eg. Kukulska-Hulme, 1990a). Writers will want to refer to previous uses of a term in their own document, in related documents or in standards or guidelines. Readers can build up a picture of a concept by looking at the various contexts of usage of a term. A lexical analysis program can in addition make significant use of information from a reference tool, and may feed information into it.

Machine-readable dictionaries are now a vital component of computer-based natural language processing systems, and their important role is being appreciated more and more. As part of such systems, their content may be intended for internal use, or as part of an interface module in the dialogue between user and machine. In instances where they are part of writing or reading systems, computer-based learning, or computer-aided translation, the user may have direct access to the lexicon, where the organisation of entries can be more or less transparent. This immediately raises the question of whether meaning representation should differ substantially for these different ends.

Dictionaries which have a rich information content

may qualify for the denomination 'knowledge base', in the sense that they provide the knowledge for lexical decisions; this is a fairly loose way of using the term 'knowledge base', which has a more precise definition within computer science. As knowledge based systems come to the forefront of computing, the reexamination of knowledge and its representation gains a significant place. Sustained by advancements in the simulation of intelligence on computers, the philosophical debate concerning knowledge and its relationship to language and logic proceeds apace (Thomason, 1989; Fetzer, 1990). Clearly, there is not a direct link between results in knowledge representation for computers and the representation of knowledge for humans, but the research has opened up a whole new field of exploration which is already contributing to an improved understanding - if only by way of contrast - of how humans process the knowledge which is to be found in texts.

Some form of intelligence can be planted inside systems, and also at the human interface, where 'intelligent' often means 'cooperative', or 'in tune with the human task'. There is now widespread recognition of the fact that it is not enough for a system to produce the right results, nor to give the user choices - it has to present them effectively, too. Thanks to a growing body of research concerned with the human-computer (man-machine) interface, enriched by investigations into the processing of visible language (Kolers et al, 1979), and by the rapid development of alternative interface technologies (icons, touch-screens, windows, mice, voice), computer users can enjoy a feeling of control which they had hitherto been denied.

As the interface between linguistics and computer science grows in scope and more cognisant bonds are formed between the disciplines, there comes the realisation that it is not sufficient to borrow theories or methods outright, but that they must be reviewed in the light of new requirements. Linguistic descriptions devised for linguistic ends are not directly applicable to computer science - and vice versa. What is more, as soon as we include human users in the computer-based language processing environment, the cognitive dimension becomes imperative. Given that each of these disciplines is currently making great headway, the challenge in research which straddles them is to strike a balance between using each discipline's most recent advances and selecting the right 'mix' of approaches for productive results.

In recent years we have seen significant developments also in the field of educational studies, with an emphasis on interactive and learner-centred learning. The learning of foreign languages now takes place in a 'communicative' context, and multimedia environments are making active learning more widespread. As reading is still one of the basic components of learning, it too must become much more interactive. The design of technical documentation will have to take account of these changes; on-line documentation presents new opportunities in this respect.

Texts may not be the most effective way of communicating specialist knowledge, but the fact is, they are still the most common way of reaching a wide and varied audience. The problem of 'knowledge transfer' or the effective communication of specialist knowledge through the medium of texts

depends crucially on the question of whether texts can be made to respond to their readers' needs. It may be a question of manipulating the representation of knowledge, of being able to transfer knowledge from one representation into another in an automatic or semi-automatic way, on the reader's demand, in order to transfer it more effectively to the reader. Language, being conventional, depends upon the interlocutors' mutual understanding of the relationships between meanings and forms; in specialised language, that understanding is more precarious than ever, so that there is a real danger of language obstructing comprehension. To counteract this situation, we can seek out these obstructions, analyse their nature, and give readers a means of seeing beyond the linguistic representation in a text.

Special subject knowledge is not confined to specialists; computer users are keenly aware of this. In order to satisfy the requirements of their job, which itself may be highly specialised, users have to take on board the special knowledge which will enable them to handle computers in an effective way. Often with limited training, they tackle applications as best they know how, turning to colleagues and printed or on-line sources (eg. manuals, help facilities) when problems occur. Many users will - consciously or not - endeavour to keep their computer knowledge to a minimum, to the level required to handle only the task in hand. The consequences are significant: for example, *computer security*, a domain of knowledge which cuts across computer applications, software and hardware systems, is an area of computing which many users, sometimes at their peril, ignore. This important area has been selected for the present study of the

retrieval and comprehension problems arising in computer manuals. It is intended that a clearer picture should emerge of how computers can themselves be used to help solve the problems which they help to create.

Chapter I

Comprehension in a terminological perspective

A.Theoretical reference points

1. Comprehension as knowledge-building

The research described in this thesis is broadly concerned with *the comprehension of computer manuals*, and more specifically, with *the language of information retrieval* from manuals. It is our view that any research dealing with human comprehension must take into consideration the very broad spectrum and variety of factors which come to bear upon that process. This does not, of course, preclude a narrow focus in the investigation of a particular phenomenon, and the present thesis is characterised by its progression from a wide perspective to a point where a particular aspect of comprehension - terminological choices in information retrieval - is scrutinised with only selected factors in mind. According to one author, comprehension can be defined very simply as "the opposite of confusion" (Smith, 1982;15); it is, however, a complex phenomenon, even "an internal, subjective process that is in general not open to external observation" (Carroll, 1972:5) - a view characteristic of the early days of comprehension research - making it difficult to define. Carroll (1972) states that comprehension contains at least two stages: (a) apprehension of linguistic information and (b) relating that information to wider context, and he makes the point that comprehension may be impeded by

the fact that messages are degraded in various ways - by transmission failures, by "unclear" or "poor" writing. Comprehension involves not only understanding "the words and grammatical structures of a message as linguistic symbols, but also taking account of those knowledges, facts, or ideas that underlie the message but are not explicitly built into it." (Freedle & Carroll, 1972:360). More than twenty years on, these remarks still hold true, and there is an abiding difficulty in trying to define 'comprehension'. From de Beaugrande's perspective (1988), to understand something "is to situate it in a network of relations that constrain its properties and connections" (de Beaugrande, 1988:10). It may be apposite to say that comprehension covers the total chain of events which begins with the writer's skill and decisions having a bearing upon the product of writing and its chances of being properly understood, includes the reader's decoding strategies, and ends with the assimilation of knowledge, enabling the reader to make decisions about action, based on new knowledge gleaned from a text.

2. Terminological processing and knowledge transfer

It is not our intention here to offer a complete psychological model of the comprehension process (see eg. Freedle & Carroll, 1972; Kintsch & van Dijk, 1978; Sanford & Garrod, 1982). There is, however, a valuable contribution to be made towards the investigation of linguistic phenomena in that process. Even more importantly, there is a new line of inquiry to be pursued which concerns the processing of *terminological* information by readers. The label "socioterminology", used in francophone

countries (fr. *socioterminologie*, eg. Gambier, 1987; Delavigne & Guespin, 1992) is useful here in highlighting the "user" aspects of terminology. There are two major reasons why terminology, with a particular orientation towards users, is so important. Firstly, in today's culture of specialisation, the terminological barrier to communication and understanding is a visible hurdle. Secondly, the advent of widely available computerised retrieval systems has brought into sharp focus the question of which terms are best used for information retrieval. There is now a much firmer conviction that "information retrieval systems are fundamentally linguistic" (Blair, 1992:200), prompting a reassessment of language theories and philosophies (eg. those of Austin, Searle and Wittgenstein) in this light. Successful retrieval is one of the keys to comprehension, conceived as knowledge-building, in a specialised domain, but comprehension is also a condition for successful retrieval. Ideally, the person who needs to retrieve information understands perfectly the domain and its terminology. In practice, this understanding may be partial or inaccurate, and the terms used when formulating a query may not belong to the domain. What is true of computerised systems is also true of conventional retrieval by way of indexes and headings, with one significant difference being that computerised retrieval is more 'remote' from the text, so that there is increased scope for manipulating the terms of a query to match those of the text.

As has been pointed out in the introductory chapter, the fields of terminology and knowledge representation are currently flourishing, and fruitful results may be obtained from research which

brings together these seemingly disparate fields. We also see a need to make more widely known the methods and findings of the field of terminology, better appreciated in mainland Europe and in Canada, but not yet sufficiently well implanted on British soil. Moreover, the design of computer-mediated communication and learning is sometimes seen as the prerogative of computer scientists, with linguists playing a supportive rather than a central role, and with apparently little heed paid to the communicative dimension of language. The research presented in this thesis represents a terminologist's view of text comprehension and the textual communication process, and incorporates research findings from a number of disciplines besides terminology: semantics, text linguistics, cognitive psychology, information science, epistemology, the philosophy of science, education, computer science (and specifically knowledge engineering). It incorporates also a description and analysis of the domain of computer security. Our particular orientation brings into focus the contribution that terminological study can make to the understanding of human processing of specialised texts, *making an explicit link between terminology and knowledge* in the context of comprehension. Above all, we are exploring the role of *terminology as a means of information retrieval*, and noting in particular that *domain knowledge can be acquired by repeated information retrieval*, whereby a picture of the domain is built up gradually. Information retrieval is thus part of the process of 'comprehending' the domain. Obviously, comprehension problems are not just terminological, or even linguistic, in nature, but information retrieval is necessarily concerned with terminology.

As has been pointed out by Alberico & Micco (1990), it is extremely difficult to construct models of information searching because "the interpersonal encounters and the information sources which are part of both reference and online searching are unpredictable and dynamic" (Alberico & Micco, 1990:65). They also point out the paradox of the searching process: trying to describe the unknown in terms of what is known. Often, the formalisation of a user's information need leads to a compromise, taking into account the chances that the information system will satisfy the need (Taylor, 1968).

Although the research undertaken here could be classed as belonging to the field of knowledge representation or *knowledge engineering*, it has been our intention to consider the specialised text as a means of knowledge *transfer*. This is to say that we are putting a special emphasis on the dynamic processes of knowledge encoding and decoding which have the text as their focus, not forgetting also that readers may infer from a text as well as decoding it. It is our view that a text does not represent knowledge in a static way, but that there is an interaction between the symbolic representation in the text and the knowledge which is activated when symbols are encoded and decoded.

'Translation of knowledge' could be used as a close alternative to 'knowledge transfer', if it did not inherit the rather narrow connotations of the term 'translation', when this refers to foreign language translation, or to the conversion of computer programs into a different programming language. Current usage apart, the term's meaning could be extended to cover any change over from one system of representation to another. Amongst the ways that a

text might be 'translated' in this broad sense are operations to condense or amplify it, paraphrase it, explain it, interpret it, represent it in symbolic form, or to change it from one language register into another. 'Transposition' is another term sometimes used in these contexts, though this also has a special meaning in encryption (message scrambling to prevent understanding). Generally, such conversions are attempts to keep - to 'carry over' - the text's conceptual framework (as far as possible) intact, while changing its outward manifestation. Sager (1991) uses "text modification" as a global term, and talks about "derived" or "dependent" texts, encompassing foreign language translations, abbreviations, extraction of sections and modifications of form, with the proviso that "no dependent text can introduce anything - information or argument - that is not in the original" (Sager, 1991:252). The rationale behind these transformations is to make a text more accessible to readers; the same applies when the 'reader' is a machine (cf. the notion of an 'interlingua' in machine translation).

'Knowledge transfer' is an expression routinely encountered in the literature on knowledge acquisition for knowledge-based systems (eg. Gaines & Boose, 1988), where it refers specifically to the transfer of expertise from expert to knowledge base via a knowledge engineer. It is also an expression which is currently being used to designate the global transfer of scientific or technical knowledge, often to developing countries (eg. Nedobity, 1990). These are not the specific meanings intended here. We are using the term to denote the transfer of domain knowledge from computer manuals to their readers, whatever their profession,

geographical location or economic standing. It is worth clarifying, however, why we speak of 'knowledge transfer' rather than 'information transfer'. "When information is organized into bodies of meaningfully interconnected facts and generalizations, it is usually referred to as *knowledge*" (Gagné & Briggs, 1979:79). The computer manual is being considered here as a learning tool, so that every instance of information retrieval from the manual contributes to the process of building up knowledge structures in the mind of the reader: "Every search for information is a learning process" (Alberico & Micco, 1990:17). Scardamalia & Bereiter (1993) have pointed out the advantages of the constructivist standpoint, favouring knowledge-building above mere transmission or reproduction. When we examine the domain of computer security, we can see that it has two aspects: preventive and remedial. Prevention involves risk assessment and planning, and this must be done on the basis of knowledge of the domain, rather than on the basis of separate pieces of information. Remedial action resulting from security breaches means tackling the problems associated with that breach, and also implementing corrective measures to ensure future security. Any information retrieval from a manual dealing with security issues thus takes place in relation to knowledge of the domain, and provides the inputs to a process of reasoning about the domain.

'Knowledge transfer' is closely related to 'comprehension' and 'learning'. Both these related terms, however, focus attention on texts and readers, whereas we would rather highlight the *process of textual communication*, with particular emphasis on the identification of knowledge.

'Knowledge transfer' is, terminologically speaking, our 'preferred term'.

3. The notion of effective transfer

It is interesting, and also necessary, to explore the notion of the *effectiveness* of knowledge transfer because in a business environment - the environment we are considering primarily -, problem solving with reference to manuals has to be productive within time constraints. Hart (1989) defines an expert's effectiveness as using knowledge to solve problems, with an acceptable rate of success. In our context, the 'effect' of knowledge transfer would show itself in the correct implementation and maintenance of computer security as a result of consulting manuals. In the long run, this could be measured in terms of how secure the system turns out to be. In the shorter term, we can consider how knowledge transfer can be made more effective by improving the process of retrieval. Furthermore, effective *knowledge transfer* is not exactly the same as effective *retrieval*. Retrieval performance can be measured in terms of recall and precision - the number and relevance of references resulting from a query (though relevance is being challenged as a chief criterion for information retrieval by other criteria such as value, utility, impact, information quality, source traits, document traits, etc. - see eg. Saracevic, 1992; Barry, 1992, and similarity measures, eg. Wilbur & Sirotkin, 1992). Effective transfer is also in the realm of understanding - the speed, the ease, the quality of understanding (see also Kukulska-Hulme, 1990b). Knowledge transfer is, in this sense, a broader term than knowledge retrieval. The key question is: how

easily can the individual manage to reach a point of resolution, a satisfying response to a query, a state of understanding ? The emphasis is thus firmly on 'linguistic ease' in the process of retrieval, and on the feelings of intellectual satisfaction and growth in knowledge that come from a query being correctly matched to an answer. It is a question of effectiveness over time, since knowledge and understanding are built up over time. The difficulties in wishing to evaluate this kind of effectiveness are explored later.

One possible definition of effectiveness would be a minimalist one: *a manual is proved to be effective in its knowledge transfer function whenever a reader manages to access with ease relevant knowledge within its texts.* It is then sufficient to show that, from a linguistic or terminological standpoint, a clear route exists from a reader's query, via an entry point to the text, to the item which - in some measure - answers the query. The goal then is to ensure that 'clear routes' are the norm rather than the exception, and to eliminate the situation where a terminological mismatch means that a search is futile or frustratingly lengthy. If this criterion is met, then at least we have created the conditions for effective knowledge transfer to take place.

4. The special role of terminology

We take the view that a text does not represent objective knowledge of a domain, but that it is a representation of a writer's subjective knowledge of that domain. This has implications for the concept of ambiguity in relation to knowledge transfer: ambiguity can result from a writer's understanding or expression of a knowledge element of the domain, or from a reader's interpretation. Furthermore, writer and reader do not necessarily share the same specialised language. The key question, then, is how does the reader elicit knowledge from the writer, the 'expert' on the subject, when communication is mediated by a text ? The reader's needs will be expressed through the rhetoric of questions, which are then reduced to terms at the 'entry points' to the text: the table of contents, index, and various prominent headings in manuals, or the query interface of a computerised retrieval system. As questions range from the general to the specific, their vocabulary will vary accordingly, and will contain words from the general language, as well as semi-specialised and highly specialised terms, perhaps from more than one discipline. The vocabulary items become the 'fishing tackle' for pulling out knowledge structures from the textual knowledge base, and much depends on the correct choice of tackle. This is where, traditionally, a thesaurus might be used to aid retrieval, as it suggests, or indeed prescribes, the use of certain terms in favour of others. Its retrieval language

"... saves the searcher the intellectual effort of bringing to mind closely related terms which might improve the search. A good entry vocabulary is another thesaurus feature which will lead the searcher from highly specific natural

language concepts to the terms used in the system to represent those concepts."

(Aitchison & Gilchrist, 1972:5).

This is the point at which formal and informal terminologies collide, and the 'user friendliness' of the knowledge base is tested.

In this light, the role of terminology is decisive; sensitivity to this issue could make the difference between enabling access to knowledge and exclusion. Terms can be viewed as linguistic pointers to knowledge, as having "special reference within a discipline" (Sager, 1990:19), and very importantly, terms are conceptually linked with one another and physically juxtaposed in text: for comprehension, relations between terms - paradigmatic or syntagmatic - might be more important than the terms themselves. If that were so, those terms which were 'better at networking', i.e. had richer, more extensive links to other terms, might be the most productive or effective in the process of knowledge acquisition - a hypothesis which would need to be tested. However, we are not asking "Which terms are the best for knowledge acquisition ?", but rather, "How can we ensure a closer match between the terms actually used by readers for knowledge acquisition (retrieval), and the terms used by writers to express knowledge in a given domain ?".

5. Language and knowledge interrelated

The definition of 'knowledge' is philosophy's central and perhaps most difficult issue, and even the narrower notion of 'special subject' or 'domain'

knowledge presents us with substantial problems. What is undeniable, nonetheless, is that knowledge can be expressed at least in part through a terminology, and we know also that a high proportion of the words which make up specialised texts are terms. Indeed, "texts have been identified as special by statistical methods determining the frequency of occurrence of terms" (Sager et al., 1980:233). A text may not explicitly assume any background knowledge on the part of its readers, its writer may even insist on the fact that it does not. It is partly a question of one's awareness of what is assumed. In particular, a knowledge of the general language must be supposed, and this cannot be separated in all confidence from a knowledge of the special language, since many words of the language function in the two spheres. In addition, writers have to gauge continually the technical level of the vocabulary they are using, and to try to predict how it will be understood, using their experience and intuition as a guide. From this we infer that the reader is faced with certain linguistically motivated assumptions about background knowledge which must be decoded in the comprehension process.

B.Terminological investigation: aims, scope and methodology

1.Relating terminology and knowledge to readers and texts

The fundamental problem being addressed is that of the relationship between a reader's usage of specialised terminology, and the terms used in a sample corpus of texts. Our hypothesis is that even

newcomers to a domain such as computer security already possess some knowledge about it because of the inseparability of specific domain knowledge from knowledge of related domains, of science and technology in general, of knowledge of the world, and more particularly - knowledge of language. These spheres of knowledge are also interlocked within texts. We therefore aim to specify the interdependence of the different spheres of knowledge, and to establish a mapping between the concepts and terminologies used by, on the one hand, the readers, and on the other, the writers, of a specific set of security texts. The ultimate objective is to suggest a generalised strategy or methodology for devising improved retrieval tools based on our findings. As the index to a manual is very often the point of entry (this is discussed later), we focus much of our attention on the index, and ask the question: "What (if anything) is wrong with the index ?" If the problems of knowledge transfer can be thoroughly researched and understood, the solutions to those problems will surely follow.

In a wider sense, the research aims to help redefine the relationship between readers and writers, with particular implications for a more flexible environment such as that offered by computers, i.e. on-line documentation and text retrieval systems. The approach taken is to try to define the problem, and suggest a methodology, which might be transferable to a practical information retrieval aid. The results could benefit either reader or writer - if the latter is willing to explore the comprehension problems of intended readers. This approach gives greater power to readers, who have hitherto had to resign themselves to playing a

largely passive role.

The motivation for this research stems from the realisation that a number of problems associated with computer manuals remain to be addressed. It is common knowledge that typically, manuals are resorted to when other sources are unavailable or lack the necessary knowledge, rather than being the first port of call. The difficulties in finding the right information are partly terminological in nature. Firstly, there are problems at the level of entry to the text (eg. via the index and table of contents). For example, we can consider some fairly simple words which spring to mind when one considers computer security: *insurance, disaster, piracy, fire protection, legal requirements, power supply, classified information, illegal sign-on, genuine user*. A perusal of an IBM manual on computer security showed that as far as could be seen from a first reading, none of these terms had been used in the manual, which suggested that a casual user might have difficulty in obtaining information from the manual. Subsequently, a small experiment was carried out (Kukulska-Hulme, 1992) to see whether terms and phrases from an introductory paper on data security (Bradburn, 1990) - see Fig. 1 - could be found in the data security section of the manual. The results showed that the degree of correspondence between the two was low - only about one word in five could be found.

Secondly, in manuals generally, there is a problem with the vocabulary of explanation, which may be unfamiliar to the uninitiated reader. Glossaries, when provided, often use and reuse the same inaccessible terminology of the text, leaving readers no wiser as to the meanings of terms. It is

this two-level terminological barrier which we set out to examine, focusing particularly on the points of entry to texts. In computerised information retrieval environments, an intermediary might be used to transform a user's query into one that can be processed effectively by the system. But today's users are increasingly keen to do their own searching, and in a paper-based environment an intermediary is not normally available.

corruption of data
deliberate sabotage
fraudulent manipulation of data
loss of data processing facilities
disclosure of sensitive data
potential risks
disruption
financial loss
breaches in data processing security
principal areas of risk
possible sources of protection
protective measures
means of damaging the computer or data
techniques to enhance security
degree of vulnerability
value of data
effects of loss or damage
disastrous effects
to reduce the probability of a fire
restrict the effects of a fire
method of recovering from damage
quick and effective recovery
replacement of equipment
preventative techniques
rigorous procedures
disaster recovery plan
adequate controls
restriction of access
positive identification of the user
backup copies of software
responsibilities of user departments
internal audit
effective day-to-day procedures
management of data security
precautions
excessive dependence on important individuals
fire and flood protection
to contain the hazard
exotic hazards such as tornadoes

Fig. 1 Examples of phrases from Bradburn's paper

Finally, it seems important to say that the whole question of domain knowledge transfer - and its vital components: terminology, knowledge, communication, learning - is so fundamental to human endeavour that any attempt to understand its problems and suggest directions for improvement is a worthwhile undertaking.

2. Computer security as an important domain

The readers under consideration are acquainting themselves with the domain of computer security. Computer security is a very important issue for those whose business depends on the functioning of their computer systems, and on the security of the information which they contain. It is an issue which cuts across different hardware and software systems, so that in spite of individual peculiarities, basic concepts prevail. However, as it is often felt that the function of assuring security does not merit a special dedicated post for that purpose, the role may be taken on by people who have little previous experience of computers or security. Madden (1990) makes the point that "security is not just the MIS director's headache; it is the responsibility of management, programmers, and end users too" (Madden, 1990:26). According to computer security consultants Mike Rentell and Peter Jenner,

"... incidents involving computers where victims have suffered serious, sometimes fatal, consequences happen surprisingly often...most of these losses could have been prevented had sensible computer security precautions been in place."

(Rentell & Jenner, 1991:1)

There is evidence that in the computing world, increasingly more attention is being paid to the question of security. Viruses are a growing concern for all users, and a frequent subject for magazine articles (eg. "Fighting off infection", Lang, 1993). In 1984, the Data Protection Act was introduced, addressing a concern "arising from the threat which mis-use of the power of computing equipment might pose to individuals" (Guidelines to The Data Protection Act 1984). The Computer Misuse Act came into force in August 1990. This provides a means of prosecuting hackers, virus creators and others who deliberately seek to access or modify computer-held data or software without authority. Software copyright is covered by the Copyright, Designs and Patents Act of 1988, and watched over by FAST - the Federation Against Software Theft. The Department of Trade and Industry has developed a special scheme - the *Information Technology Security Evaluation and Certification Scheme (ITSEC)* - providing an independent evaluation of computer-based security products and the certification of products which meet appropriate standards; the United States has provided such a service since the early 1980's ("Orange Book" issued by the Department of Defense), and European standards are gradually being harmonised. There has also been an IT Security Awareness Programme, managed by the National Computing Centre (NCC), comprising information packs, consultancy, management briefings and courses (eg. "Keeping IT safe"), and extensive publicity in the media.

In spite of these initiatives, some attitudes are slow to change. Two comments from users noted on our survey questionnaires (details of the survey are given later) will serve to make the point:

"Senior management do not realise the importance of computer security nor the ramifications of illegal copying of software. The 'it won't happen to us' attitude prevails."

"Problem with bosses who appear to give little credence to the need to adhere to conventions and want everyone to have access to everything, in the name of efficiency !"

It is not only system operators who need to be helped to understand security issues but also their bosses. While computer security is the domain selected for the research presented here, it must be stressed, nonetheless, that the nature of the research and its findings means that the implications go far beyond this particular domain, and indeed beyond computing and computer manuals in general. This is discussed in the conclusion.

3. Sources of information on computer security

NCC Consultancy has published a 'Survey of Security Breaches Report' (NCC, 1992), detailing how organisations are establishing security plans, and dealing with legislation and disciplinary procedures; it also gives an overview of types of breaches encountered. There are numerous books on computer security, including those published by NCC Blackwell, such as Elbra's "Computer Security Handbook" (Elbra, 1992; see also Ellison & Pritchard, 1987; Smith, 1988; Simons, 1989; Roberts, 1990; Hearnden, 1990; and other books mentioned in later section on the domain of computer security). Articles appear regularly in academic and professional journals and the computing press (eg.

Albert et al., 1992; Burns, McDermid & Dobson, 1992), and in specialist periodicals, eg. Elsevier's "Computer Fraud and Security Bulletin". The ACM (Association for Computing Machinery) Special Interest Group on Security, Audit and Control publishes a quarterly "SIG Security Audit and Control Review", and organises conferences on the subject of security (eg. Annual Computer Virus and Security Conference). Computer security standards are published by standards organisations (eg. ISO, BSI, ANSI), and the Institute of Electronic and Radio Engineers in the UK. On-line conferencing systems (BIX, CIX) are another source of information in this field. On the terminological front, Butterworths has published a dictionary of security terms and concepts (Fay, 1987); the Department of the Secretary of State of Canada is a good source of up-to-date translation glossaries, particularly in the many related fields (eg. English-French Security Equipment Glossary, 1993).

Apart from this information of a general nature (i.e. applicable to computers in general), there is information pertaining to specific systems. For example, the magazine "IBM System User" regularly publishes articles on IBM system security. For IBM's AS/400 (Application System/400) mid-range system ('mid-range' being roughly equivalent to a 'mini' computer, in more widely accepted terminology), which has been chosen as the focal system for this project, there are several sources of information on security. The main written source is manuals; occasional articles may be found in the journal "News 3X/400", for IBM System34, System36, System38 and AS/400 users (eg. Conte, 1990); information about security is also available in the "on-line help" facility on the system. On-line help can be

accessed in several ways:-

- "User Support" - offers general information about the system, a database facility for logging questions, and "online education" - a library of interactive tutorial modules tailored to different types of user. The latter includes a module entitled "System Security Concepts"

- commands related to security can be accessed by calling up a list of command groups; 'security commands' form a distinct group, but commands relating to security can also be viewed by selecting a different group type and then making further selections, eg. to find the command for changing passwords:-

verb commands	-> change commands
	-> change password command CHGPWD

OR

subject commands	-> security commands
	-> password commands
	-> change password command CHGPWD

Help panels are available to explain the commands, with 'extended help' if required, hypertext links available from highlighted words, and suggestions of related topics.

- one further way of getting help is through a "search index", which will accept words or phrases (whole sentences can also be typed, but the system clearly works on a word/phrase basis). This can be a good way of getting quickly to a chosen topic. It exhibits, however, the classic linguistic shortcomings of this type of retrieval system,

discussed in Chapter III.

4. Primary data: users and texts

The research described in the present thesis is based on two main sources of primary data: linguistic data elicited from a sample group of computer users (in charge of an IBM AS/400) by means of a questionnaire in which they were asked to write down questions about security on their system; and textual data from a sample manual on computer security. The manual, "AS/400™ Security Concepts and Planning - Version 2", 1st edition, April 1991, document number SC41-8083-00, was published by IBM Rochester (permission to use this manual for research in printed and electronic form is gratefully acknowledged). This manual was originally only available in printed form, but was subsequently also issued in CD-ROM disk format, with accompanying BookManager retrieval software. It is the main comprehensive manual on AS/400 security; as with all manuals, updated and improved editions are being regularly issued as new versions of the operating system are released, but for this research it was necessary to refer to a single edition. Security issues are also dealt with in IBM publications related to AS/400 Communications, OfficeVision/400 software, operations, the application programming interface (API), and programming and utility security. Further details on the user survey are to be found in Chapter IV.

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5. Evaluation criteria for effective transfer

At this point we must come back to an issue raised earlier about the evaluation of the effectiveness of knowledge transfer. As noted, knowledge transfer is to do with understanding, with the emphasis on 'linguistic ease' in the process of retrieval, and on feelings of intellectual satisfaction and growth in knowledge - the confidence of knowing. An evaluation of these largely (though not entirely) subjective outcomes would be a separate and substantial undertaking, and although our research can postulate the likelihood of an improvement in the effectiveness of knowledge transfer conceived in this way, it stops short of actually testing that particular hypothesis. What is more, the evaluation of long term system security, as a result of knowledge transfer, might prove a better criterion, and though the effect would clearly be secondary, it should show the vital link between knowledge and action (using knowledge effectively). Awareness and knowledge can contribute to effective security, as can adequate technology, but there is one other key factor, commitment: "Technology can and should be used to preserve security but it will depend on human commitment to be effective" (Elbra, 1992:1). The problem is complex, but by limiting our scope, we are able to concentrate on the detailed terminological and knowledge-based investigations of retrieval problems which are the hallmark of our research in this sphere. The essential criterion, then, is successful look-up: finding what one is looking for thanks to a mapping between user needs and access devices. However, "the critical issue to be examined...", as Itoga (1992:330) put it, advancing an 'alternative framework' for mapping information needs in communication, "... is not how

to describe human information seeking behaviour, but how to understand another person's information needs". The need for our user-oriented, language-oriented approach is confirmed also by Smeaton (1992) when he writes about the current limited role of Natural Language Processing techniques in information retrieval research:

"... This role does not really address issues of retrieving information for users based on the language used in queries or in texts. Fundamental issues and questions dealing with the notion of a retrieval model and document relevance will need to be integrated with what NLP techniques have to offer if really significant progress in retrieval effectiveness is to be expected."

(Smeaton, 1992:277)

6. Progression in stages in a multifaceted approach

The research path deemed to be the most appropriate here is one that takes as its starting point a review of the fundamental notions of "knowledge" and "domain knowledge" in relation to computer security, then provides the opportunity to discuss knowledge transfer environments, before moving on to an empirical investigation of users' knowledge needs.

The particular stages of the research may be outlined as follows:

(1) *Discussion of theories and sources of knowledge*; presentation of a catalogue of knowledge types, with particular reference to the relationship of knowledge and language; overview of approaches to the organisation and representation of knowledge - individual units and fields of knowledge, and especially lexical and terminological

configurations.

(2) *Exploration of the notion of 'domain knowledge':* what is domain knowledge, how is it organised and represented, what are the ramifications of its transfer to a person from a written source ? Characterisation of the domain of computer security in terms of knowledge representation and linguistic expression.

(3) *Specification of the means of access to knowledge in texts:* how is knowledge encoded by writers and communicated to readers ? What are the real needs of readers in particular situations, and how do they access texts to fulfill those needs ? What specific access mechanisms are there in texts ? How is knowledge assimilated ? What specific communication and access problems are there in the domain of computer security ?

(4) *Review of existing environments* which aim to facilitate the transfer of knowledge, accompanied by an evaluation of computer-assisted retrieval and learning, and discussion of the value and effectiveness of self-instruction from manuals. Specific discussion of retrieval on the IBM AS/400 system.

(5) *Empirical study to establish readers' knowledge needs*, with reference to knowledge types sought and the use of terminology to express specific needs, using a questionnaire. Creation of a database of queries. Analysis of reader profiles.

(6) *Qualitative analysis of knowledge needs expressed in the query data:*

Lexical and terminological analysis: by grammatical category, with discussion and further semantic and knowledge-based categorisation

Intentional and rhetorical analysis: query clustering by knowledge-seeking purpose and rhetorical form; discussion of rhetorical difficulties and the question of ambiguity

Overview of knowledge types and dominant knowledge needs: summary of needs as revealed by the qualitative analysis

(7) *Quantitative analysis of source preferences and expectations*, with a comparison of the two.

(8) *Characterisation of the computer security manual*, with particular reference to its organisation, readership, and access devices. Special study of its index as a point of entry, in relation to the needs established earlier.

(9) *Summary review of the relationship or mapping between readers' needs and the access facility of the manual*: what are the problems which hinder knowledge transfer ?

In summary, we have set out to examine the relationship between the knowledge needs of readers, as expressed through their language, and the knowledge expressed by writers within the confines of the computer manual. We would like to see terminology as a facilitator of knowledge transfer; it is hoped that our conclusions and proposals will help bring this about. We begin by exploring, in the next chapter, the notions of 'knowledge' and 'domain knowledge', with special reference to the domain of

computer security.

Chapter II

The nature of domain knowledge

A.Theories of knowledge

1.The inference/experience dichotomy

In order to gain a better understanding of the knowledge representation issues being tackled in this thesis, we begin with an overview of the basic distinctions that have been made within the theory of knowledge by those who at one time or another have set themselves the task of trying to ascertain what is to be understood by 'knowledge'. As epistemology is a general science, it is equally important to examine the relevance of its propositions to the specific fields of computing and computer security, and to determine the distinctive features of the latter with respect to the substance and organisation of knowledge.

The essential search for the foundations of knowledge has over the centuries been embodied in two contrasting philosophies, one hailing reason (Descartes), the other experience or perception (Locke, Ayer, Russell). Both are centred on the individual person's self-access to knowledge. Perception may be the ultimate source, but it would seem that some knowledge can also be gained by way of inference, and memory has a supportive role in this respect. The empiricist would not accept that human reason or thought can itself produce new knowledge; mathematics and logic are, however,

considered to be exceptions. The *a priori* knowledge possible in these disciplines is in contrast with a *posteriori* knowledge, the more common type. Noninferential (a posteriori) knowledge may be attained with or without observation (as in the case of knowledge of our sensations).

It is partly in response to the skeptic's doubting of the very possibility of knowing that knowledge has been formulated in propositions, the truth or falsity of which could be subjected to verification. A priori knowledge can often be verified on the basis of analytic definitions ('a crayfish is a crustacean') or synthetic a priori truths (eg. 'every event has a cause'), but if something is only contingently true, it should be established by experience. Verification is particularly important in the context of knowledge-based computer systems, where incorrect knowledge will lead to incorrect inferences. Knowledge is bound up with the criteria of truth and meaningfulness; the truth-value of a proposition could change with time; in fuzzy reasoning, there are degrees of truth; in illocutionary acts (Austin, 1975), the true/false distinction does not apply. Knowledge must furthermore be considered in relation to the notions of certainty and confidence: the "first degree of factual knowledge" can be knowing, but not having the confidence of knowing (Pears, 1972). In spite of this element of uncertainty, for most philosophers, knowledge is not to be equated with beliefs or states of mind: states of mind are changeable, beliefs can be false. It is to be noted that the scope of knowledge is wider than that which may be obtained as a result of one's own individual powers (Hamlyn, 1970). Hence the need for both spoken and written communication.

For knowledge engineers, knowledge may be distinguished from expertise on the grounds that: "... experts are experts because of what they are able to do with their acquired knowledge" (Hart, 1989:15), or in a similar vein, expertise is knowledge plus inference, and ultimately, "*knowledge is concerned with action ... effective use of knowledge leads to the formation of plans of action*" (Graham & Jones, 1988:21). However, it is important to add that, as well as having the ability to act, experts have the ability to theorise, and so to further knowledge, to refine it. And since the more we know, the more we realise there is much we do not know, an expert's knowledge develops into *value judgment*: what is worth knowing, its relevance to a given situation, the probability that something will occur, what needs to be discovered. In this sense, if we equate belief with judgment, we can accept an expert's belief as being knowledge, even though belief or judgment can change. However, it is also possible to identify belief with "received knowledge", and judgment with "experiential knowledge."

2.Sources of knowledge

Knowledge "... has two important characteristics: (a) it is modified and extended by experience, and (b) it is linked in a number of ways with previously acquired knowledge" (Last, 1989:115). Experience is an important aspect of knowledge acquisition, for even if it is not the primary source of an element of knowledge, it may come in at a later stage, altering and supplementing knowledge in some way. In everyday language, experience amounts to successes and failures - we talk about learning from

experience. Knowledge is thus tested in a situation, and modified as a result - its major characteristic is change.

We also sense the importance of 'hands-on' experience when it comes to learning something we will have to imitate, and observation is often better than explanation. First-hand experience seems superior to second-hand knowledge, though it may be coloured by subjectiveness. To take the point further, we can ask whether there are areas of knowledge which may be inadequately - or not at all - acquired through language. It seems that we are questioning here the adequacy of language as a means of knowledge representation; if the representation is inadequate, knowledge transfer must be imperfect by implication. This is a problem well known to those who build expert systems, trying to capture and represent 'expertise'. Belkin, Brooks & Daniels (1988), who have used the technique of discourse analysis of user-intermediary interactions in a situation of computer-based document retrieval, list the standard knowledge elicitation techniques as being interviews (informal or structured), verbal protocol analysis (recordings of experts thinking aloud), and observational studies. Experience has shown that some aspects of knowledge may not be open to introspection or verbalisation:-

"... people's awareness of their own mental processes is rather limited. The proceduralization of knowledge and automatization of cognitive skills that accompany the development of expertise, serve to make expert thinking even less accessible to introspection."

(Slatter, 1987:33)

Moreover, we have to take into account the

limitations of natural language: "Natural speech is marked by part-sentences, contradictions, omissions and repetitions... The use of words is often inconsistent and imprecise" (Hart, 1986:61). Gaines (1988) makes a related point when he states that expertise "may not be expressible in language. An expert may not be able to transmit the expertise explicitly because he is unable to express it", and "... expertise may not be understandable when expressed in language. An apprentice may not be able to understand the language in which the expertise is expressed" (Gaines, 1988:4). On the other hand, the most characteristic feature of discourse in natural language is "its ability to deal with incompletely and inexactly expressed concepts and to resolve and assimilate contradiction" (Graham & Jones, 1988:77). These linguistic problems have long stood in the way of expert systems becoming widespread in use, since one of their aims is to hand on expertise to the less experienced: it is not enough to represent knowledge, you also have to communicate it well.

Given that in some situations written documents are the only available, though secondary, source of knowledge, we have to accept and bear in mind their shortcomings, including their fragmentary, incomplete nature. Texts represent fragments of knowledge, but they are also its *focus*: they have a recording function, they serve as a canvas for working out ideas. Their organisation and specific function - whether didactic, descriptive, narrative, expository, synoptic, encyclopaedic, enumerative, argumentative, legislative and so on - harnesses elements of knowledge and imposes a structure. To this, the writer adds personal selection and idiosyncratic ordering of knowledge elements. The coherence factor of any piece of discourse can make

it difficult to extract one element without losing the ties necessary for understanding. Also, understanding depends on where you are in the text, and is likely to be compromised if a reader did not start at the beginning of a sequentially organised text. For fast retrieval of knowledge, a thematic organisation is normally preferable to a sequential one, but even then there is always implicit reference between themes. Even reference books such as encyclopaedias and dictionaries cannot delimit the scope of their entries in any final way. To a large extent, it is up to the reader to use skill and judgment to reduce the volume of information on offer and to select only that which is relevant, useful, or appropriate in other ways.

3. An overview of knowledge types

A basic typology of knowledge may be derived from the grammatical structures of the verb 'to know' - hence '*knowing that*' (*factual, theoretical or declarative knowledge* - *current or historical*), '*knowing someone or something*' (acquaintance with particulars or universals, directly - through experience - or by description), and '*knowing how*'. However, no clear demarcation line between these types is implied, and there is a certain mobility: one type can become another (eg. when theoretical knowledge is applied, or when a description goes on to explain how something should be used). Categories of knowledge are more often than not "hopelessly entangled one with another", as Last has put it (Last, 1989:121).

'Knowing how' may imply knowledge of a methodology or procedure, or the ability to successfully carry

out a procedure oneself. Common alternative labels include '*practical*' or '*applied*' knowledge, in opposition to '*theoretical*'. Furthermore, since '*knowing how*' is usually the result of active experience rather than passive observation or cogitation, the successful application of knowledge is a matter of *cognitive or motor skill*. Whiting (1975) defines skills as complex, intentional actions which "through the process of learning have come to be organised and coordinated in such a way as to achieve predetermined objectives with maximum certainty" (Whiting, 1975:6). '*Procedural knowledge*' is a present-day label used in computer science. It is helpful in making the connection between knowledge and learning: procedural knowledge requires procedural learning, declarative knowledge - declarative learning (Waern, 1989: 71). In the field of knowledge engineering, researchers have found that, "as expertise develops, there is a shift towards procedural forms of knowledge representation" (Slatter, 1987:29). Knowledge can be modelled, but some domains, "... such as child-rearing, have no definitive models - forcing the expert to rely heavily on *heuristic knowledge*" (Slatter, 1987:27) - rules of thumb, or "inspired guesses" (Hart, 1986:20), based on experience as well as theoretical knowledge. 'How to' knowledge can also be described as '*instrumental*' or '*operational*'. When knowledge is the result of having experienced or studied case histories (eg. the case method in the American legal system), '*casuistic knowledge*' (used in a derogatory sense in Ethics) or '*case knowledge*' might be more appropriate. The development and refinement of an expert's knowledge eventually leads to the possibility of *value judgment*.

Researchers working on knowledge representation systems make use of the notion of *control knowledge*. This is knowledge that eg. a rule based (production) system must have to control the 'firing' of rules: "Metarules are rules which control the use of domain rules" (Williams & Bainbridge, 1988:106). Control, or *strategic knowledge* (Clancey, 1983), specifies the ways in which knowledge elements are used; it describes "when" and "why" rules should be applied. "Control knowledge describes what to do, when and why (knowledge which can be extremely important to a novice)" states Anna Hart (Hart, 1989:59). It seems that the notion of control in relation to knowledge systems could be a very important one, given that "the most essential factor in the dynamic operation of a system is control, definable as a process for managing the relation between determinacy and indeterminacy" (de Beaugrande, 1988:9). Alexander (1992) uses another label, "*conditional knowledge*", to indicate that it is concerned with "when" and "where".

Gaines (1988) has devised a model of knowledge acquisition based on the premise that knowledge is culturally transmitted, i.e. by a process whereby each person shares the results of knowledge creation and development by other members of a culture. According to this model, at the lowest level there is *reflexive knowledge* or *mimicry*, which has no verbal component and comes directly from experience or from watching an expert at work. This informal knowledge is in contrast with *formal knowledge*, rule-based, induced, transmitted verbally or by reinforcement - eg. by working under expert supervision. Next, there is computational or *technical knowledge*, usually transmitted by rational, technical explanation, perhaps through

books, followed by *comparative knowledge*, transmitted by simile or metaphor, by transfer from related worlds or cultures. At the highest levels, we have *abstract knowledge*, induced or transmitted through mathematical representation, encompassing basic laws, and finally, *transcendental knowledge*, which refers to the transfer of general, systemic principles.

What emerges all along here is the transition from discrete items of knowledge to an awareness of systematic, ordered knowledge, whether in the form of relationships, rules, principles, or steps - understanding how things fit together, how one thing affects another.

Another basic distinction can be made between *foreground* and *background* knowledge, useful for processing purposes (computational and human). In computer systems which are programmed to understand natural language, for instance, 'background knowledge' includes hierarchical representations of systems of concepts, knowledge about the basic laws of the universe in question (eg. properties of objects and how they change), knowledge about methods of performing actions, and how a microworld will change as a result of such actions, procedural knowledge in the form of global schemas - scripts (Memory Organisation Packets - MOPs), plans, plot units, and themes (eg. Thematic Abstraction Units - TAUs) (Schank & Abelson, 1977; Galambos et al., 1986). Schema theories of knowledge representation presuppose top-down processing, where larger structures are used to interpret new pieces of information as they are encountered in the comprehension process. This type of knowledge can be said to be *generic* (see also "domain knowledge"

discussed later). *Causal knowledge* can be conceived in terms of chains of events comprising actions, states, and the causal relations connecting them (Schank's conceptual dependency theory - Schank, 1975). The actions in a schema can be prioritized (central/subsidiary), and are characterised by their relative distinctiveness and varying frequency of occurrence. *Temporal knowledge* has posed a particularly difficult problem for knowledge representation in artificial intelligence systems, yet it is necessary for "... sophisticated world models that can capture change over time within them" (Kwong, 1988:190). A further category of knowledge may be proposed: *restrictive knowledge*, comprising conditions necessary for concepts to occur, non-equivalence between concept systems in different languages, or conceptual gaps. Closely related to this is *negative knowledge*, encompassing all that we know to be untrue.

Background, or *prior knowledge*, has been examined by psycholinguists researching the phenomenon of inferences in text processing (Rickheit & Strohner, 1985). Inferences are said to be generated from *prior world knowledge*, much of which is *social knowledge*. This includes, for example, knowledge of personality traits in general - extroverted, hostile, crazy, etc. - allowing a reader to predict how a person with these traits will behave; *stereotype categories* - waitresses, policemen, black people, middle aged, etc.; *prototypic situations* - a doctor performing surgery, a cowboy riding a horse (Clark, 1985), and so forth. Closely aligned to this is *cultural knowledge*: knowledge of the cultural context with its conventions of communication. But text comprehension is also influenced by *personal knowledge* - knowledge of the world and of linguistic

rules and conventions, conditioned by sex, age, education, occupation, personal attitudes and emotions. Next, there is *verbal context* to consider, i.e. knowledge of those parts of the text which have been presented previously. A distinction can then be made between *a priori* inferences, drawn from the reader's background knowledge, and *a posteriori* inferences, drawn from the text already processed (Crothers, 1979). Sometimes this distinction is conceived in terms of *current* information and *stored* knowledge. Kakkuri-Knuuttila & Kusch (1991), Finnish researchers representing a philosophical approach to text interpretation theory, quote Hintikka's notions of *active* and *tacit knowledge*, developed to include *potential* and *virtual knowledge*, made apparent through question-posing. Nystrand (1986) writes about *mutual knowledge* as being the knowledge that two or more individuals possess in common, which allows for establishing a mutual frame of reference in communication.

Background knowledge is not only encyclopaedic in nature but also *linguistic*. Our personal knowledge of linguistic rules and conventions covers grammar, phonetics, semantics, pragmatics. It encompasses our personal understanding of the meanings of items in the lexicon, which may include incorrect perceptions of meaning, and the special meanings of words which function as terms in narrow subject domains.

4. Knowledge and language

As we take stock of the many different types of knowledge, we are drawn inexorably to consider the relationship between knowledge and language. In particular, we can ask whether knowledge which has

been gained through direct contact, observation or experience, and then expressed (described) in language, has been altered in some non-trivial way, for example due to the linear, sequential nature of discourse which may be at odds with the concomitant nature of aspects of an event experienced or observed. The crux of the matter is that readers of manuals can only access knowledge which can be mediated by language (graphical representations apart), and language comes charged with prior meanings - that is to say, the reader has previously encountered most of the words - and many of the terms - in other contexts and will have a preconceived idea of their meanings, based on usage in the general language or in other knowledge domains. After all, according to Ludwig Wittgenstein's dictum, *the meaning of a word is its use in the language*, and most words' meanings will have been determined by previous use. As well as having "inherent features", each lexical unit displays "contextual features" (Chafe, 1972), and both can prime the meanings encountered in new contexts. The knowledge of a large collection of rules relating word form and meaning is a part of the language user's 'competence'. The reader, then, has the ability to understand language, and the ability to misunderstand.

When we come to examine and try to classify types of knowledge expressed in discourse we come up against the problem of language ambiguity. Ambiguity is present at the lexical level in the shape of polysemy, synonymy and imprecision, it is present at the syntactic level, it is recognised in the phenomenon of unclear antecedents (anaphora), and it is brought on by grammatical inaccuracy and spelling error. Ambiguity is particularly striking in the

question form, a major means of knowledge elicitation. A 'simple' question: "Can you swim to the other side ?" can have three meanings - (1) do you know how to do it (2) please do it (3) are you allowed to do it. Similarly, Browning (1984) draws attention to the ambiguity produced by 'may' ("You may initialize the equipment by pressing switch 1"). The problem can be resolved, to some extent, by probability and contextual clues, but this is nevertheless a substantial difficulty.

The relationship between words and meanings has absorbed scholars since the very beginnings of linguistic and philosophical enquiry, and it is worth pausing to consider the views which have been put forward. The main challenge has been to capture the essence of word meaning in abstract terms, but there has also been the need to make explicit the meanings of individual items in the lexicon, and to explore the compelling notion that these are somehow interlinked. In particular, if word meanings were to be handled and conveyed - a need which imposed itself when the first dictionaries were conceived - they had to be made tangible and explicit.

However, not only do the meanings of words change over time, but the perception and representation of meaning is influenced by a number of factors, notably current technological trends. Technology provides a conceptual framework through which meaning may be viewed. In current vogue is the information processing analogy, and to a certain degree, this dictates the choice of meaning representation. The representation may be implemented on a computer, and since computers are used to simulate mental and linguistic activity, this in turn may colour the perception of meaning.

It may further be supposed that the specific needs of individual systems or applications can become the overriding factor where meaning representation is concerned.

One thing can be stated with absolute confidence: meanings are not encapsulated in individual items of the lexicon. The dependence of word meaning on word settings and the interrelated nature of the 'intensions' of words is well documented in modern linguistic theory. Indeed, one of the tensions characterising meaning representation is how to reconcile the practical necessity of representing the meanings of individual lexical items with the desire to provide a full description by reflecting their relationship to other words and meanings in a given sample of language or in language as a whole.

In the central problem of lexical semantics - that of the relationship of words to their meanings - a long-established approach is referential: the essence of meaning is specified by establishing an interdependence between words and the things or concepts they denote. This is typified by the 'meaning triangle' of Ogden and Richards (1923): a word symbolises a concept, and stands for a referent. It may be fair to say that the analysis of the interrelation between the linguistic sign and concept or referent is not strictly speaking the object of linguistic enquiry. The main alternative is then a functional approach to meaning, where the aim is to study the meanings of a lexical unit through its relationship to other units of the language rather than its relation to either concept or referent. It is also possible to view the functional approach as being complementary to the referential one.

Although lexical items express meanings, these meanings are not fixed: they change when viewed from a diachronic perspective, and synchronically lexical meaning is dependent on linguistic and extra-linguistic context. The study of shifts and developments of meaning over time, which includes tracing the passage of technical terms into the general language and vice versa, is complemented by a study of potential meanings: the potential lexicon.

The grammatical interdependence of linguistic forms makes meaning a function of a lexical item's position in the discourse structure in which it occurs, and a product of the interplay of meanings of items which make up the context. Meaning is also dependent on the culture of a particular language community - including professional cultures - as evidenced by the phenomenon of non-equivalence between languages, and the communication problems associated with the use of 'jargon' terms. Neither is meaning tied to form: homonymy and homography are commonplace phenomena.

Lexical meaning can be perceived as a pattern of syntagmatic and paradigmatic relations or affinities between the constituents of a lexicon in a given language (Cruse, 1986). A lexical unit could be a morpheme, a word, a variable word-group, even a phraseological unit (eg. Ginzburg, 1979). John Lyons (1981) uses the term 'lexeme' to designate 'lexically simple expressions', in opposition to lexically composite ones. The question as to what constitutes a unit of lexical meaning has implications for all aspects of the study of lexis, and is especially important for natural language processing (eg. Sparck Jones, 1985).

From a lexicographic perspective, methods of word definition give us further insight into approaches to word meaning: a definition can identify a word's position in relation to other words of the language (synonymous, analytical and synthetic definitions), or it can make reference to extra-linguistic reality (eg. denotative and ostensive methods). A lexical item is therefore most commonly defined either by connotation - a set of criteria for belonging to a class, or denotation - a set of referents. In technical writing, there is sometimes a need for operational definitions (Sides, 1984:30) or for definition by exemplification (Kukulska-Hulme, 1990c:54). A further method of defining words - the provision of a citation - suggests that meaning can be implied through verbal context. In the course of this century, collocations have been added to the lexicographer's arsenal of methods: to list collocations of words is to express their meaning in terms of their collocability (Firth, 1957).

The last twenty years have seen a rise in interest in the relationship of syntax to semantics, and by extension in the relationship between syntax and lexicon. In the early transformational-generative work of Noam Chomsky, grammatical description was non-semantic, but gradually the need to incorporate semantic restrictions was recognised. Consequently, lexical meanings used for generating sentences were decomposed into semantic features. More recent work in generative grammar tends to make the dividing line between grammatical and lexical meaning progressively less sharp. Proponents of Montague grammar have attempted to establish an even closer correspondence between the two. Hudson (1984) has argued that the internal structure of a word can be generalized to act as the basis for generating

syntactic structures, so that there is no fundamental distinction between 'rules' and 'lexical entries'. Mellish (1985) advocates 'early semantic analysis' as an alternative to the traditional approach of syntactic parsing followed by semantic interpretation. In 1980, a semantics-oriented 'word expert' language parser was reported by Small (Small, 1980); a semantics-driven approach characterises also the Distributed Language Translation project (Papegaaïj, Sadler & Witkam, 1986). Specific interest in lexical knowledge representation has led Viehweger (1991) to conclude: "Meanings are knowledge representations of states-of-affairs in reality characterized by complex internal structures that are flexible and dynamic" (Viehweger, 1991:263).

In information retrieval, we have to consider the semantics of individual terms, multiword terminological units, phrases, as well as simple and complex sentences. Of particular relevance is the *performative* or *illocutionary* nature of language; Blair (1992) has, in fact, proposed a document indexing structure based on John Austin's taxonomy of illocutionary acts (Austin, 1975). We must remember that user queries perform the action of information retrieval, even though an intermediary mechanism or algorithm must be used to map a query effectively onto the knowledge in a database.

5.Domain knowledge and specialisation

We have so far discussed knowledge - and language - without explicitly relating them to specialisation. Knowledge of a specific field of learning or experience - a science, a technical field, an arts

subject, a sporting activity - can usefully be referred to as 'domain knowledge'. It is, however, necessary to consider definitions of this term, given that it is used by different people in different ways. Alexander, who specialises in this question (see eg. Alexander, 1992), defines domain knowledge as "the realm of knowledge that individuals have about a particular field of study" (Alexander, 1992:34). In her view, background or prior knowledge is advanced to the level of a domain when it becomes a focus of study. When knowledge is based around fundamental generalisations and is highly organised, it can be termed "*discipline knowledge*". This represents a learner's perspective of domain knowledge, where a progression in knowledge is emphasised. Possession of domain knowledge is what is generally said to distinguish an expert from a layman, quite apart from their different modes of operation and abilities. There are, indeed, degrees of knowing, so that one can, for example, talk about someone having a 'basic' knowledge of a subject, 'advanced' knowledge, and so forth; knowledge can also be 'partial' or 'incomplete', and there have been numerous studies of knowledge acquisition examining the "novice-expert shift" (eg. Anderson, 1985; also Nystrand, 1986, who describes "knowledgeable" and "unknowledgeable" readers). Research into text comprehension has yielded the labels "*high domain knowledge*" and "*low domain knowledge*" to help explain the relationship between expertise and the number of inferences drawn during text comprehension: the greater one's knowledge, the more inferences are drawn (Rickheit, Schnotz & Strohner, 1985). In information retrieval systems, domain knowledge can be conceived as "information about important topics and concepts in a specific domain

and how they relate to each other" (Brückler, Florian & Kalcher, 1988:151). This is a subject-oriented view of domain knowledge. We have to take both perspectives into account, since we are concerned with matching a user's (learner's) developing domain knowledge to the domain knowledge represented in a body of texts.

According to Hart (1989), experts are characterized by the following features: *effectiveness* (using knowledge to solve problems, with an acceptable rate of success), *efficiency* (deducing probable solutions quickly, determining relevant information quickly), an *awareness of the limitations* of their knowledge, and *versatility* in unfamiliar situations. We would hope to be able to use an expert "as we would a text book with a question-answer facility, where the answer meets our particular requirements, and is phrased in terms which we can understand ...", and to be able to question the expert about how he or she reached certain conclusions, but it is also recognised that experts are characterized by an "... inability to explain high-level problem-solving activity without ambiguity" (Hart, 1989:17-18).

The practical need - as well as academic aspiration - to model expertise has created the concept of 'domain knowledge'. This special subject knowledge has a corresponding special subject language - a language for a 'special purpose' (Kittredge & Lehrberger, 1982; Hutchinson & Waters, 1987) - though such language is not a separate, delineated entity in relation to language as a whole. The distinction between 'general knowledge' and 'knowledge of a special subject' is, of course, not new. What is relatively new, however, is the way we model special subject knowledge ("a subspace

of the knowledge space" - Sager, 1990:16), and the need to represent domain knowledge in a symbolism other than natural language in textual form.

B.The organisation of knowledge

1.Units of knowledge

In this section we review several approaches to the identification of knowledge units, in an attempt to shed light on the relationship between terminological units and units of knowledge. From an encyclopaedic perspective, knowledge can be expressed in texts, with referential links between them, but since a 'text' is a hazy concept in terms of its length, content, and even general characterisation, it seems more productive to look at better defined units of knowledge - not necessarily primitive units, but ones that are more distinctly formed.

From a philosophical perspective, elements of knowledge consist of propositions, a proposition being an abstract entity, an object of thought. A proposition can be expressed in a sentence ("a sentence expresses the proposition which is its meaning" - Landesman, 1972:6); a statement is a sentence uttered with the intention of asserting something true. Propositions refer to individuals and universals, and can be existential, attributive, or relational. True propositions are otherwise known as facts; if there is uncertainty, assumptions are made. The philosopher (eg. J.R. Searle, 1979) might make a distinction between *brute facts* and *institutional facts* (flavoured with conventions and activities characteristic of human institutions).

Drawing on this philosophical basis, computer science has provided us with another perspective on knowledge units, through its need for accurate and workable representations. In the field of knowledge engineering, systems are built on the basis of knowledge elicitation techniques which identify facts, assumptions, and rules. An expert has a large number of perceptual patterns, or "chunks", that "... directly index part of the expert's knowledge store. A chunk is a familiar configuration of elements that through repeated exposure comes to be recognized as a single unit" (Slatter, 1987:28). Experts may be unable to make these chunks explicit by formulating rules, but may be able to list symptoms or characteristics, with possible decisions, and subsequently match the two. Knowledge engineers have to deal with the incompleteness and uncertainty of an expert's knowledge.

In the context of computer database systems, natural language interfaces can be based on knowledge about the meaning of words relative to a specific environment. The environment is modelled, and a certain portion of the model is assigned to the word as its meaning. Relations are then established between model parts and are represented as hierarchical, network, relational, and binary relation models. Entities, attributes and relationships are the basic ingredients of the conceptual structure, or schema, of a database. Conceptual design aims to represent these ingredients in a form that is comprehensible to the user and independent of any specific system. "The problem is that representation mechanisms that are user oriented tend not to be very database oriented, while representation mechanisms that are design oriented force the users to make many representation

decisions in order to get the information into a processible form" (Teorey & Fry, 1982:57). Since users are interested in the information content of a database, not in its physical or logical structure, designers have had to develop high-level information representation structures for conceptual modelling. Conceptual design can be seen from two perspectives (Teorey & Fry, 1982). One of these, 'object representation', aims to define the relative structure of the abstract objects or concepts of a system. In this view, objects are related to other objects in two ways: as a collection and as a class, which can be formalised through 'aggregation' and 'generalisation' (Smith & Smith, 1977). Aggregation forms an object as a relationship between other objects, while generalisation forms an object from a class of other objects. The more traditional perspective for conceptual design is entity modelling, particularly as elaborated by P. Chen (1976). In the entity-relationship model, information is represented through entities, attributes (properties or characteristics) of entities, and relationships between entities. A relationship can be defined as an association between one or more entity types, reflecting relationships in the real world. It is worth noting that the standard ANSI/SPARC framework for database systems (Tsichritzis & Klug, 1978) is based on three schemata (conceptual, internal and application schema) which map directly to the three vertices (concept, referent, symbol) of the referential meaning triangle of Ogden and Richards (1923). The GLOT terminological data bank in Stuttgart (Mayer & Maier, 1987), implemented using the ORACLE relational database, has been conceived along these lines. It caters for generalisation and aggregation hierarchies, and for associative relations.

This brings us to the theory of concepts as encountered in the field of terminology. Terminology work in its best known form is based on Eugen Wüster's General Theory of Terminology (1974). The theory aims to delimit concepts before attempting to assign terms to those concepts. Concepts can be defined by intension (specification of the concept's characteristics) or by extension (enumeration of all species at the same level of abstraction or of all individual objects belonging to the concept). A concept is roughly equivalent to the 'meaning' of a term, but unlike linguistic meaning, a concept exists independently of a term: they are two separate entities united arbitrarily. Terms are linked to concepts through relations of monosemy, polysemy, synonymy, homonymy, and equivalence (Picht and Draskau, 1985).

Concepts as units of knowledge "do not exist without being related to other concepts" (Budin et al, 1988:52). They are said to be directly related if they have the same characteristics in their intensions. They are indirectly related if the individual objects which they represent are contiguous in space or time. According to Felber (1984), three main types of relationship are possible: logical, ontological, and relationships of effect. Logical relationships include intersection, subordination, coordination, and diagonal relationships. Ontological relationships can be partitive, successive, and can relate material to product. Relationships of effect comprise causality, tooling, descent. Picht and Draskau (1985) classify logical relations as consisting of identity, implication, intersection, disjunction, and negation. Other relations cited by them from the German DIN standard 2330/2331 are ontological

spatial/temporal relations, cause-effect, producer-product, material-product, sender-receiver, tool-application, argument-function. Sager (1990) lists a selection out of what he emphasises is a very large number of possible relationships, including phenomenon-measurement, object-counteragent, object-container, activity-place, and so on.

Terminography aims to record terminological data which gives a precise description of a concept and of the relationships between a concept and other concepts. This information, along with data such as sources, field of application, grammatical notes, definition, context, etc. constitutes a terminological record. A typical record for a documentation thesaurus stores information about conceptual relationships of three types: hierarchical, associative, and equivalence (preferred term). A complex terminological record can indicate concept coordination and overlapping, or indeed any of the relationships analysed in the course of terminological work. The type of information actually included depends on the orientation of the data collection, typically standardisation, translation, or language planning.

At this point we can make some observations concerning the relationship between terminological units and knowledge units. We have seen that from a terminological perspective, it is concepts, not terms, that constitute units of knowledge. As has been pointed out by Sager (1990), concepts are notoriously difficult to define; it is, however, possible to group them into four basic types: *class concepts* (or entities, generally corresponding to nouns), *property concepts* (or qualities, for the most part corresponding to adjectives), *relation*

concepts (realised through different parts of speech), and *function concepts* (or activities, corresponding to nouns and verbs) - [see Kukulska-Hulme (1989) for an account of an analogous grouping in the design of dictionaries for translators]. We can consider systems of concepts and endeavour to specify relationships between concepts, uncovering the knowledge structures which bind them together. But we cannot do the same with terms. Terms are existential in nature, that is to say they signal the existence of an entity, a relationship, an activity, a quality. Considered outside of verbal context, they can express neither facts nor rules, they can say nothing about the manipulation of knowledge. Furthermore, many concepts, particularly of the relational and functional types, are designated by words of general, not special, reference. Here, then, is the crux of the matter: in a situation of knowledge retrieval from a written source, how can a terminological unit represent a specific knowledge need, other than one which seeks only to discover the concept (meaning) of a specific term or to confirm the existence of a concept ? The procedural, functional, relational, control aspects of knowledge are not well served by terms as symbols of knowledge units outside of context. This must be borne in mind when considering the process of retrieval and knowledge transfer.

There is one other aspect to this. As Smeaton (1992) has pointed out,

"It has always been assumed by researchers that in language it is the noun phrases that are the content-bearing units of information. This is not true for a full representation of meaning but noun phrases are good indicators of text content and for traditional information retrieval, that is what is wanted."

(Smeaton, 1992:272)

The emphasis on 'noun phrases' and thereby on class concepts in preference to other concept types may indeed be appropriate for traditional information retrieval, retrieval which presents the user with a list of references as its outcome. But in full-text systems, and in relation to natural language user queries, one has to keep an open mind as to which concepts and elements of expression will be the most effective, the most representative of a user's intention.

2.Domain knowledge representations

We have already seen that it is difficult to separate units of knowledge from the structures in which they are embedded. All knowledge structures have a function: organising, guiding, helping understanding, making access to knowledge easier. The basic structure of knowledge can be said to have three components: categories, rules for category membership (distinctive features), and category interrelations.

The domain knowledge representation problems which are still being addressed today were already recognised in the 1960s and 1970s. Early natural language processing systems made extensive use of semantic primitives and networks (eg. Masterman 1961, Ceccato 1964, Quillian 1968, Wilks 1972, 1973). It was partly due to the lack of success of the earliest machine translation systems that researchers turned to the broader issues of how language understanding might be simulated, and how to enable effective human-computer communication to take place. Natural language communication became an important area of research both in artificial

intelligence and in database technology. A lexicon-driven approach to the analysis of language characterises much of recent research, eg. Cullingford's (1986) ERKS system.

Natural language understanding is part of the more general aim of simulating human cognitive processes on the computer. Models of linguistic competence and performance are built in an effort to simulate this aspect of human cognitive activity. The difficulty lies in the fact that "characteristic for human language understanding is the fact that meaning cannot directly be constructed from some basic units of meaning. Instead, complex relations between the model objects enter as well into the meaning of language units such as words" (Krageloh & Lockemann, 1978:50). Highly complex models of the linguistic component of cognition are required, since the semantics of natural language statements must remain largely unrestricted.

The questions that concern us here are whether lexical semantics can be separated from world knowledge or encyclopaedic knowledge, and whether the representations which might be used for words can have the same form as representations of other kinds of knowledge. In 1987, a round table meeting of experts under the auspices of the Commission of the European Communities (McNaught, 1987) confirmed the lack of consensus in this sphere. For instance, a multilingual lexical knowledge base could be designed to contain 'language-oriented' or 'real-world oriented' knowledge, or a combination of the two. Some existing systems make an explicit distinction: for instance, in their national electronic dictionary project, the Japanese (Ishiwata, 1985) have opted for a two-part modular

design (a linguistic knowledge base and a distinct conceptual taxonomy); an R & D project at Carnegie-Mellon University (in McNaught, 1987) separates syntactic (domain independent) knowledge from domain-specific (i.e. semantic) knowledge, and uses a lexicon to link the two.

In a typical knowledge base, both structural and causal relationships between component entities are recorded. The symbolic representation of these relationships can be achieved by IF-THEN rules, semantic nets, frames, or Horn Clauses. Frames can be used for representing concept prototypes (eg. Nissan (1987) makes use of static, consulted frames, implemented as deeply nested relations), since they can contain default values. Fass (1987) has implemented a lexicon of 'sense-frames' consisting of arcs and nodes that correspond to the genus and differentia of standard dictionary definitions; the arcs of all the sense-frames comprise a 'sense-network': a structured semantic network of word-senses. Graham & Jones (1988) make the point that different knowledge representation formalisms are appropriate for representing different kinds of knowledge, eg. frames for object knowledge, semantic frames for associative knowledge, production rules for causal knowledge, and so forth.

Systematic enquiry into the nature of the lexicon relies largely on the application of principles borrowed from other disciplines, specifically from mathematics, and more generally from the philosophical ideas which have underpinned the development of science. The origins of many lexical analysis techniques, like componential analysis, associative pairing, or antonym pairs, can be traced as far back as the theories of the ancient Greeks,

Indians and Chinese. In the West, Aristotle was the first to distinguish between two kinds of associations of ideas, namely logical relationships (based on similarity) and ontological ones (based on contiguity in space or time). He developed deductive reasoning, thus laying down the first laws of logic. In more recent times (18th Century), the logical relationships of superordination, subordination, and co-ordination were explicitly described by Immanuel Kant.

Symbolic logic is based on an extensional approach that has proved useful in mathematics. Often natural language needs to be represented in fuzzy logic (Zadeh, 1975), rather than discrete logic, since it reflects the continuous, non-discrete nature of the world. And, as has been pointed out by Ilson (1987), natural language itself is probably the best metalanguage: it has "the flexibility - and the fuzziness - to describe the properties and emulate the behaviour of its own lexical units" (Ilson, 1987:71).

The rigorous nature of analysis methods based on mathematics and logic contrasts with the more flexible approach inherent in a cognitive view of lexis. It is true that technical vocabularies reflect the ordered nature of the subject fields they represent; to these collections, strict rules of classification may be applied. The general vocabulary, however, tends to elude such rigour. No single method for specifying word meanings can hold good for all items of the lexicon. Some words are best described by listing their features, some by enumerating their parts. Sometimes meaning can be elucidated through context, or through related words. In other cases one might use an antonym, or

place the word's meaning on a scale, or name an object's function, or attribute it to a class. Equally, no single configuration is applicable to every set of words. In the end, what matters is the purpose for which meaning is specified.

For automatic processing, a standard representation is required. Even in cases where a certain liberty is permitted, for instance in naming relation types, the format of the representation must be made uniform, relation types catalogued, access routes and operations sharply defined. Without this, processing cannot take place. Yet standardisation can compromise accuracy of meaning. And so for human use, even if intermediate storage in a computer system is envisaged, lexical items and their meanings need a representation which is primarily compatible with the cognitive process in which the lexicon is an aid. The problem is that while a computerised process can be clearly specified - be it a conventional algorithm or a set of inference rules - an intricate human process (for instance, reading) cannot be captured in quite the same way. This makes it even more difficult to devise an appropriate meaning representation for such an end, since the precise nature and progression of the process remains largely unknown.

Symbolic logic continues to be applied to the problem of the representation of meaning, although it is essentially different from natural language with respect to both syntax and semantics. In the field of knowledge engineering, 'conceptual graphs' are an attempt to address this problem. According to J.F.Sowa (1984), conceptual graphs "form a knowledge representation language based on linguistics, psychology, and philosophy. In the graphs, concept

nodes represent entities, attributes, states, and events, and relation nodes show how the concepts are interconnected" (Sowa, 1984:69). A conceptual graph, which asserts a single proposition, is part of a larger 'semantic network'. Conceptual graphs are used to represent the meaning of propositions as an intermediate stage in language parsing and generation, using relations such as agent, recipient, object, attribute, cause, destination, duration, instrument, material, negation, successor, and so forth. The content of conceptual graphs is determined by conceptual analysis, whose essential goal is to produce a precise, formal catalogue of concepts and relations.

Charles Fillmore's case grammar (1968) has had a strong influence on semantic work in artificial intelligence, providing convenient labels for relations: agent, instrument, object, source, goal, etc. Language parsers have made use of these conceptual relations, but the idea of incorporating them into dictionaries has come more gradually (eg. Somers, 1980).

Nearly all types of conceptual analysis carried out across the disciplines of knowledge representation and lexical semantics share the basic distinction between intension and extension. 'Intension' is a roll-call for concept, connotation, sense, attribute, property, feature, primitive, data description, definition, inference rule, criterion, class...; it is the basis for sense relations which are logical, superordinated, intersected, overlapping, networked within the language; it creates associative, semantic, conceptual fields; it accounts for fuzzy sets and prototypes. 'Extension' evokes referent, denotation, species, object,

physical entity, file, list..., and relationships
which are ontological, partitive, collective,
successive, contiguous in space or time.

3. Lexical and terminological configurations

It is interesting, though not surprising, to note that the problems of knowledge representation overlap with those of meaning representation, i.e. lexical semantics. Lexical semantics is concerned with the meanings of lexical items but also with the identification and representation of semantic relations between lexical items. Lyons (1981) has called these 'sense relations'; the sense of a lexical expression is the set of sense-relations, both combinatorial and substitutional, that hold between it and other expressions in the language (eg. synonymy, hyponymy). An earlier examination of lexical relations by R. A. Waldron suggests that it is also possible to consider the way in which "the referential function of one term is linked up with the referential function of other terms, so that the vocabulary appears rather as a system of reference than as a battery of separate referential words" (Waldron, 1967:95). Saussure discussed different kinds of associative relations between words, association being established through a common root-element or suffix, through similarity of sound, or meaning (Saussure, 1972:174).

Cruse (1986) has provided us with a survey of lexical semantics in which he makes reference to paradigmatic (congruence) relations, comprising the logical categories of identity, inclusion, overlap and disjunction, and to syntagmatic relations, comprising philonymy, tautonymy (pleonasm) and xenonymy (dissonance). This is not a clear-cut classification: the existence of partial and pseudo relations is also acknowledged. These and other sense relations can be used to construct lexical configurations, typically in the form of hierarchies

(taxonomies, meronomies, chains, helices), proportional series, lexical opposites and sets of synonyms.

Ginzburg et al.(1979), in an earlier account of semantic classification, distinguish four approaches: conceptual fields, hyponymic relations, semantic similarity and contrast, and word families or clusters. A conceptual field can be seen as a set of lexical items in which the meaning of each item is determined by the presence of the other items. The classification of words into word-families or clusters means that a group may be composed of words with semantically and possibly phonemically identical root-morphemes, or of words with identical affixational morphemes, where further categories such as agent or action can be seen to emerge.

Lexical groupings may be based on the notion of associativity, in which case we are dealing with unstructured, unsystematic groupings, or 'clusters'. Associativity has been a dominant concept in research concerned with the workings of the mental lexicon. In the 1960's and 70's, the associative structures of the 'subjective' were investigated, using methods such as linear graph analysis, hierarchical clustering, and multidimensional scaling on carefully selected domains (eg. Fillenbaum & Rapoport, 1971). The aim of this type of research has been to find out to what extent generalised associative structures can be uncovered for a given domain, how restricted domains are interlinked in the subjective lexicon, and how semantic knowledge develops.

Summarising relevant psycholinguistic research in this field, Aitchison (1987) describes the two major

components of the mental lexicon: the semantic(-syntactic) and the phonological component. Her account is concerned with the spoken word; it has to be stated that the interrelationship between the spoken and written forms is not well understood (eg. Allport & Funnell, 1981). It appears that the semantic component of the mental lexicon is arranged in a network divided into semantic fields, with multidimensional links of various strengths between words. The links can be of several types - coordination, collocation, superordination, synonymy - but the connections between coordinates, especially those of the same syntactic class, and between collocates, are particularly strong, while the other links are weaker. The division of the lexicon into the two components reflects the different needs of speech production and recognition: the semantic component is geared towards production. The method of retrieval of lexical items can be explained through a 'spreading activation' model (eg. Stemberger, 1985), whereby a large number of nodes on the network are activated, and those that are not required are then gradually suppressed.

The semantic net was devised explicitly as a psychological model of human associative memory. According to A. Narayanan (1986), association is to be found between items which occur simultaneously or in close succession, or which are similar or contrary. Association can be direct (stored in direct physical or logical contact in memory), or indirect (occurring at recall time). The most recent metaphor for memory organisation and function is a distributed parallel processing system. In this model, it is possible to say that "each node of a semantic network corresponds to a particular pattern

of activity over a large number of units. A node can then partake in many different patterns of activity (...)" (Narayanan, 1986:249); a node can be interpreted as representing a concept, but it also represents a pattern of activity at a lower microlevel. Links between concepts are generated by many simultaneous interactions at the level of their microstructures.

Another approach, under the banner of 'cognitive grammar', equates meaning with conceptualisation, where the latter "encompasses novel conceptions as well as fixed concepts; sensory, kinesthetic, and emotive experience; recognition of the immediate context (social, physical, and linguistic); and so on" (Langacker, 1986). Lexical items are recognised to have a considerable array of interrelated senses, which may be conveniently represented in network form.

The theory that the mental lexicon is organised along the lines of a network is one of two predominant theories or models of this aspect of the human mind. The other main theory, that of semantic primitives (with its associated technique of componential analysis, or lexical decomposition), was the dominant viewpoint some twenty years ago (eg. Wierzbicka, 1972). The work of Schank (1972) is much quoted in this sphere; some of the 'meaning atoms' or 'primitives' identified by him were later shown to be complex notions, which were further decomposable, and other important criticisms have been levelled at this theory. In 1976, the psychologists Miller and Johnson-Laird tried to elaborate it by linking semantic primitives to perceptual primitives; however, other aspects of the meaning of words (eg. the function of objects)

are not perceptually based, and these aspects had not been captured. Although there is no substantial evidence to support the theory that word meanings are split up into primitives in the mind, semantic decomposition is still a useful approach for organising meaning in the 'objective' lexicon (eg. Cullingford, 1986). For example, a study using componential analysis carried out by Ortony, Clore and Foss (1987) has produced a taxonomy of the affective lexicon. A few typical classification problems have emerged in the course of this work: the variety of syntactic forms in the lexicon; problems of ambiguity where a word has both a physical and a psychological interpretation; the elusive nature of antonym pairs, some of which belong to the same category, while others do not.

Componential analysis, though it has been shown to be defective both theoretically and empirically (eg. Lyons, 1981), is still considered to be a useful way of formalizing the focal, or prototypical meaning of lexemes. It has served to show that for some polysemous words, it is difficult to identify a 'semantic core', and continues to reaffirm the view that in general, word meanings are fluid, or fuzzy. Only a very small number of words have fixed meanings, so that a set of necessary and sufficient conditions can be specified. However, when categorising objects, people appear to know the characteristics of an 'ideal exemplar' or 'prototype' of the object in question (Rosch, 1975).

Another approach to the formalization of lexical structure is the relation of entailment (a relation between propositions p and q , such that, if the truth of q necessarily follows from the truth of p , then p entails q). Although entailment is normally

applied to propositions, it can be used in connection with lexical items, for example: 'dog'=>'animal'. Entailment is at the heart of 'meaning postulate' theories which assume that there are no semantic representations for words, only inference rules (eg. Fodor, Fodor & Garrett, 1975). Meaning postulates were introduced by Carnap (1956) to state the relationships between the intensions of words. Some doubt has since been cast on the validity of such theories, eg. by P.N. Johnson-Laird (1978, 1987), who has, in turn, advanced his own, psychological theory of the representation of lexical meaning. This asserts that there appear to be comprehensive lexical entries in the mental lexicon, containing specifications of the senses of words. Elements of a lexical specification can consist of "(a) relations to other words, which could be represented by a mechanism akin to a semantic network, and (b) ineffable primitives that are used in constructing and manipulating mental models of the world" (Johnson-Laird, 1987:208). Words can enter the lexicon through direct acquaintance with their denotata, or, if they have a more complex semantics, they may be acquired from definitions, or from encountering instances of the word in use. In the lexicon, most entries for words are in fact likely to possess elements of both types of information (i.e. specifications of their truth conditions obtained through direct acquaintance, as well as relations to other words obtained through verbal definition or encounter). The contents of an entry may be incomplete, and in the case of 'natural kind' terms, a major component of the representation of sense will consist of default values.

C.The specialised domain of computer security

1.Introductory remarks and definitions

Having discussed the concepts of special reference, domain knowledge and specialisation, we now turn to look in some detail at the specialised domain of computer security. In Chapter I, we listed a number of sources of information on computer security. There are many books available on this subject, some covering the entire field (eg. Becker, 1977; Hsiao et al., 1979; Hearnden, 1990), others a particular aspect of computer security (eg. fraud - The Audit Commission, 1985, 1987; access control - Wood, 1985; viruses - Highland, 1990), or a given sector (eg. commerce and industry - Oliver & Wilson, 1983). Some list potential problems and report cases of security breaches (eg. Rentell & Jenner, 1991), giving 'facts and figures' (Pritchard, 1979), suggesting practical solutions and security products (Hruska & Jackson, 1990). Recent books tend to include network (communications) security, and some of the issues of computer security are also touched upon in books dealing with 'health and safety' (eg. Broadhurst, 1991).

We do not propose here to give an exhaustive account of the subject, since this has been done very well by the authors mentioned, who are computer security specialists. In particular, for our purposes we are not so much interested in a systematic classification of the field, nor in a list of problems and solutions, but rather in its characterisation from the point of view of knowledge types and terminology. Nevertheless, the starting point and subsequent reference framework must be a brief description of the main constituents of the

domain, which we will base largely on James Cooper's exhaustive and authoritative volume: "Computer and Communications Security: Strategies for the 1990s" (Cooper, 1989), published in the United States, and supplement it with information from Tony Elbra's "Computer Security Handbook (NCC Blackwell - Manchester/Oxford, UK, 1992). Cooper's book also contains copious references to further reading on all aspects of the subject, while Elbra's book has extensive "checklists" and "guidelines" for every aspect of security. The necessarily brief description presented in the next section is only a top-level representation of the subject.

The Shorter Oxford English Dictionary defines 'security' as, on the one hand, 'the *condition* of being secure, protected from danger, doubt, or care' (synonymous with safety), and on the other hand, as 'a *means* of being secure' (a protection, guard, defence, guarantee). Specialists sometimes choose to make a distinction between security and safety, for instance on the basis of degree of harm caused (security problems cause relative harm, eg. gain or loss in competitive advantage, safety problems - absolute harm, eg. when a service or resource is impaired, a company goes out of business: Burns et al., 1992). Cooper mentions the effect of computer security on safety (eg. in air traffic control), but security is the key term in his book, where he states: "Briefly, security is protecting "assets"" (Cooper, 1989:11).

It is worth bearing in mind that 'computer security' is a subdomain, or particular concern, of a broader 'security function'. In commerce, industry and government, 'security' is a function which aims to protect a particular organisation, installation, its

machinery and data, etc. from known threats. Certain security procedures are required or regulated by legislation such as the Health and Safety Act, the Data Protection Act, the Official Secrets Act, the Theft Act, and so on. Security and safety are guaranteed by implementing and maintaining measures resulting from an assessment of risk. The 'security function' can encompass all of the following major issues:

Policy and management

- appraising risks
- formulating a security policy
- disaster planning
- planning for industrial action
- access control
- staffing of security
- allocation of responsibilities for security
- maintenance of security records and reports
- security audit

Offences against security - prevention and legal action

theft	industrial espionage
sabotage	negligence
criminal damage	bribery and corruption
assault	trespass
arson	blackmail
bomb threats	burglary
extortion by kidnapping	
forgery	
fraud, inc. computer fraud	

Environmental hazards - prevention and action

fire	flooding
power failure	explosion

2. Brief description of the domain

Aitchison & Gilchrist (1972) suggest that to define a subject field, you should establish the boundaries of the subject and distinguish between the central area, and marginal or peripheral subjects.

"Boundaries" seems too definitive a word, but it may be said that from a computing perspective, or in an organisation or department where computers play a crucial role, computer security is central within the security function. It is also worth noting that computer security is implanted in the wider field of technology. This dual allegiance is easily explained by the two components, 'computer' and 'security': either can be emphasised. Significantly also, computer security 'rubs shoulders' with the domains in which computers are applied, eg. business, and with the legal system.

The three key concepts of computer security are said to be confidentiality, availability, and integrity. Computer security has particular concerns which stem from the fact that information produced by computer systems is often time-critical, that systems harbour potentially sensitive and important data, and that access takes place through communications systems which can be difficult to control. A distinction is usually made between *physical security* and *data security*, and more recently, *network security*. Standby facilities are all-important, and the main hazards are environmental disaster, loss of information (accidental or deliberate) through computer or human error, negligence, unauthorised access, sabotage and fraud.

Cooper's book covers risk analysis and other forms of security analysis, and resource allocation;

security is then broken down into six 'security environments': *physical, personnel, regulatory, hardware, software, and networks*, covering the following topics:-

Physical:	intrusion prevention intrusion detection information destruction power protection fire protection water protection contingency planning
Personnel:	personnel as assets personnel as threats personnel ingenuity personnel security techniques
Regulatory:	national security sensitive unclassified information privacy issues computer and communications security laws international topics
Hardware:	hardware integrity hardware access control electrical and electromagnetic threats information-tapping techniques personal computer security tamper-resistant seals
Software:	software threats software access control National Computer Security Center resources

File and Database security

Network: network architectures
 communications security threats
 dialup security and hackers
 encryption and cryptanalysis
 authentication and digital
 signatures
 automated network administration

This classification, which has further levels of subdivision, shows quite clearly how the growth of the domain (coupled with the growth of computing) has made it necessary to identify separate areas for analysis, each one a candidate for being labelled a specialised domain in its own right. However, the boundaries are not clear-cut, and the protection of an asset will typically require several layers of security, eg. regulatory, physical and software. The environments are subsequently prioritised depending on the type of organisation; and so for organisations concerned with commerce or business, the order of priority is: personnel, physical, software, regulatory, network, hardware. Across different organisations, "... physical protection has a strong overall role in security, as does UPS (*uninterruptible power system*) protection. Separation of duties, background screening, and effective password systems also have high overall importance" (Cooper, 1989:359). Elbra's (1992) classification gives additional prominence to management (managing security/ risk management), internal auditing, back-up and recovery.

In an introductory section, Cooper lists and defines the six key terms in computer security, the "entities within the environments": *assets, threats,*

vulnerabilities, risk, protective measures, and responses -

"... "assets" may be information, hardware, software, peripheral supplies, people, communication media, processing capabilities, or money ... the "threats" to assets are 1) people who choose to be adversaries, and 2) happenstance due to people or nature ... Vulnerabilities are features (design, configuration, procedure) that allow threats to affect assets ... "risk" can be viewed as the probability that a given asset will be lost through a specific vulnerability due to a particular threat ... "Protective measures" are security features that are incorporated to minimize vulnerabilities and/or risk. "Responses" are security moves made after an incident. These may be in the form of corrective measures, analysis, or necessary actions (prosecution, recovery)"

(Cooper, 1989:12)

He then makes the point that security problems should be addressed in a sequence of steps - first identify the assets to be protected, then identify threats to those assets, examine vulnerabilities, assess risk, select protective measures to reduce the risks, monitor events in order to take responsive action. This approach corresponds closely to the CRAMM risk analysis methodology developed under the auspices of H.M. Government's Central Computer and Telecommunications Agency (CCTA). A "CRAMM review", usually conducted by a licensed consultancy (eg. NCC Consultancy - NCC, 1991), produces an asset valuation, threat and vulnerability study, risk assessment and recommended countermeasures. This general procedure is also advocated by Elbra, who highlights the need to allocate responsibility for IT security.

The domain knowledge representations which emerge from this high-level view of computer security confirm that a 'mix' of representations is necessary

to convey the various types of knowledge in the domain. There is a need for structure, and within the structure a need for listing facts, describing entities with their attributes and states, specifying relationships, outlining procedures, prioritising and evaluating, linking cause to effect. Terminology helps to delimit and relate conceptual knowledge, and in this way assumes a 'high profile' role in representing the domain. The characterisation of the domain of computer security in terms of both terminology and knowledge types, reported below, will contribute to the emergence of a clearer picture of potential knowledge transfer problems. Some of these problems are caused by the complexity of the domain. As has been pointed out by Kettle (1992): "Overall the subject is so complex that it is not easy, even for an insider in computing, to see any order in the pattern of threats and countermeasures" (Kettle, 1992:198).

3. Characterisation in terms of knowledge types

As noted, the domain of computer security is related to a number of other fields of knowledge. It is not possible, and not necessary, to draw clear boundaries between such fields of knowledge. In particular, the narrower a field, the more difficult it is to describe without constant reference to the wider fields in which it is embedded. Besides, one field can be viewed from two or more completely different angles: for example, "computing" can be seen from an electronics/ electrical engineering perspective, or from a business viewpoint, amongst several others. Bearing these points in mind, it may be said that in Cooper's book, the following domains are represented:

science & technology

- a history of technological developments in the introduction; scientific & technological concepts throughout

computing

- concepts throughout; some explained in glossary

mathematics

- mathematical formulae, esp. for risk analysis, resource allocation, encryption, password generation, information redundancy

security

- the key concepts (assets, threats, risk, etc.) are global security concepts

business

- business environment identified as having special security concerns; business case studies throughout

law

- identified as a sphere for consideration (regulatory environment); case studies with legal overtones

world

- world knowledge used to promote understanding of issues

language

- specific attention drawn to terminology; familiarity with abstract words assumed

The reference point for a more detailed analysis is the 'overview of knowledge types' presented earlier. In what follows, the aim was to find out whether some (or all) of the knowledge types identified could be traced in the book by Cooper. If so, the relevance of these types to the representation of knowledge in the field would be noted; however, no attempt was made to assess the degree of representation. What follows are examples of items of knowledge, with a typological label (and a page

reference). As indicated earlier, categories overlap, and a statement can be found to express more than one knowledge type.

It was found that a very wide range of knowledge types was represented in the book. As the book emphasises strategic planning and awareness, along with expert knowledge of threats, risks and responses, rather than the practical implementation of solutions (cf. Hruska & Jackson, 1990), there is a tendency towards description and enumeration (tools, techniques, options, case histories, typical situations, examples), which means that tactical control knowledge is less well represented. It is, of course, necessary to stress the incidental nature of the examples given: a statement formulated in one way will represent one knowledge type, but reformulated in another way may represent a different type. Among other factors, pragmatic considerations are known to influence an author's choice of words (see eg. Myers, 1989). Still, it is the ability of formulations to signal knowledge which is our prime concern, even as we recognise that there is no perfect relation between formulation and knowledge type.

The following knowledge types - 19 in total - were identified. Examples are given for each type.

<i>declarative</i>	<i>value judgment</i>
<i>comparative</i>	<i>prior verbal context</i>
<i>restrictive</i>	<i>non-verbal</i>
<i>heuristic/experiential</i>	<i>cultural</i>
<i>prototypical</i>	<i>transcendental</i>
<i>case</i>	<i>world</i>
<i>practical</i>	<i>stereotypical</i>
<i>procedural</i>	<i>linguistic</i>

causal
temporal

strategic/control

DECLARATIVE

(factual)

"Software bugs can also cause disasters." Pg. 91

(historical fact)

"The Los Angeles Department of Water and Power was victimized in early 1985." Pg. 223

(technical fact)

"Various forms of overvoltage protection are available such as arc-breakdown devices and metal-oxide varistors." Pg. 76

COMPARATIVE

(analogy outside of domain)

"Homer's description in The Illiad of a Trojan horse ... has a software analogy. Hence the name." Pg. 222

(similarity, within domain)

"The similarity to "checksums" is also apparent."
Pg. 170

(difference, within domain)

"A cipher is distinguished from a code by virtue of the secrecy implications." Pg. 311

RESTRICTIVE

"This appears to be an attractive concept, but there are significant problems." Pg. 235

"This technique is feasible where large controlled fenced areas enclose a facility." Pg. 204

HEURISTIC/ EXPERIENTIAL

"Users in general are incapable of generating (or unwilling to generate) secure passwords." Pg. 235

PROTOTYPICAL

"Overwriting typically involves multiple overwrites of alternating magnetic polarity signals ..." Pg. 66

CASE

"For example, a London chemical company was victimized ... Scotland Yard intercepted and arrested the men. The lesson is ..." Pg. 59

PRACTICAL

"There are several ways in which entry can be protected. One is to try to ensure that software vendors are known ..." Pg. 231

"Some of the tools and techniques are: ..." Pg. 271

PROCEDURAL

"... it was recognized that seven steps would be necessary to verify the implementation specifications: 1. ... 2. ... " Pg. 259

"Once the alignment is found, groups of letters thought to represent a word are picked out of one ciphertext stream and checked ..." Pg. 317

CAUSAL

"This vulnerability can result in the insertion of a TH (Trojan horse) or a virus, for example, into a network thought to be immune to outside threats."

Pg. 301

TEMPORAL

"It is important to periodically test processing at reciprocal sites." Pg. 88

"Then, if the virus is purged from a particular version of the system (before or after destructive action), the seeds of further destruction have been planted, ready for action when the backup copies are used." Pg. 223

VALUE JUDGMENT

"... no asset approaches the value of people. Some of the reasons for this value judgment are ..."

Pg. 99

"These solutions are only partially effective."

Pg. 232

"... I believe the benefits outweigh the risks."

Pg. xviii

PRIOR VERBAL CONTEXT

(explicit reference)

"This was the technique described in the previous section ... " Pg. 314

"Returning to the case where the available budget ... is less than the expenditures ..." Pg. 33

NON-VERBAL

(mathematical)

Equations for the 'Doppler' effect in intrusion detection. Pg. 62

(schematic)

Diagrams for the operation of the "Data Encryption Standard". Pg. 319

(ostensive)

A photograph of a fingerprint verifier. Pg. 186

CULTURAL

(explicit - not prior)

"France has several unusual political features."
(Re: French legislation on security) Pg. 148

TRANSCENDENTAL

"We feel a moral and humanitarian obligation, one that transcends any monetary investment, to protect human well-being." Pg. 41

WORLD

"Love is one of the most powerful of all human motivators, so it should be no surprise that love plays a role in computer crime." Pg. 107

"Nature can also create exposure." Pg.36

STEREOTYPICAL

"... basically honest people who suffer from momentary temptation." Pg. 106

LINGUISTIC

"A new vocabulary has developed in order to describe a series of new attack methods ..." Pg xvi

"Complete agreement on terminology is often not achieved." Pg. 11

"Hot sites are computer facilities designed to be occupied in an emergency." Pg. 88

"'E' occurs about 13% of the time ..." (Re: cryptanalysis) Pg. 315

STRATEGIC/CONTROL

'Strategic' is a global term in the context of Copper's book, since the title specifies the coverage of "strategies for the 1990s". Hence, all of the above knowledge types may contribute to 'strategic knowledge'. Sometimes the word 'strategy' appears in the text:

"The final strategy mentioned ... requires that ..." Pg. 89

Although 'control knowledge' can be synonymous with 'strategy', it can also be interpreted as having a more immediate, tactical resonance, catering for the need to know 'what, when, and why' - as well as 'where and how' - in specific circumstances. This kind of knowledge is not in evidence in Cooper's

book.

4. Terminological and lexical characterisation

Computer security terminology is growing and changing, reflecting the growth of the domain. Cooper is very much aware of the problems of terminology. He points out that new vocabulary items are constantly developing in order to describe new attack methods, eg. viruses, worms, Trojan horses, time bombs, logic bombs, trapdoors, salami attacks. These new techniques, with their imaginative denominations, testify to the popularisation of the domain. At the same time, specialists are still struggling with the core terminology ("Complete agreement on terminology is often not achieved, even for those of us who are professionally involved in computer and communications security", Cooper, 1989:11), and with the terminologies of technological advancements (eg. local-area networks (LANs) and wide-area networks (WANs) - "These types of terminologies are not crisp", Cooper, 1989:283). Some concepts present veritable "dilemmas", such as the definition of 'risk' - should the emphasis be on high probability, or high potential loss ?

Hruska & Jackson's (1990) book is interesting from a terminological standpoint: the table of contents features very accessible expressions (eg. "forgotten or lost passwords", "rubbish disposal", "time-bomb from ex-employee", "wiping disks securely") alongside more technical headings ("electromagnetic radiation", "virus in CMOS RAM"). Hearnden's edited handbook (1990) has chapter titles completely devoid of specialised terms. Most books on the subject published in recent years contain a glossary of

about 100-350 terms at the back of the book. Typically, these glossaries explain computing and communications terms ("EPROM", "broadband"), scientific and technological terms ("Halon", "Faraday shield"), security terms ("sensitive"), and computer security terms ("virus", "scavenging").

An analysis of a wide range of computer security handbooks shows that the following categories of words, terms and expressions may be encountered (some relatively uncontentious examples are given, though polysemy precludes a final categorisation, and it goes without saying that categories overlap). The analysis is lexical as well as terminological, as words of general reference have been included. At this stage, a separation of the two spheres of reference is not required. As with knowledge types, the wide range of reference fields should be noted. 'Value-laden' items (expressing value judgment) occur in several categories, not only in the general language.

GENERAL LANGUAGE

building, windows, completely, similar, different, malicious, accidental, major, damage, attack, sufficient, currently, incident, important, motive, disadvantage

ABSTRACT and SCIENTIFIC LANGUAGE

strategy, plan, approach, analysis, factor, feature, procedure, rule, constraint, effective, problem, solution, detect, identify, facility, conditions, effect, error, failure, probability

TECHNOLOGY

install, machine, voltage, sensor, device, pressure, batteries, ferroresonant, inverter, waveform, circuitry, infrared, ultrasonic, lock, filter, surge protector, transformer

COMPUTING

Formal:

data file, screen, backup, electronic mail, buffer, CPU, file directory, formatting, ROM, LAN, operating system, plotter, modem, sequential access, write protect, byte, ASCII

Informal:

the computer is down, hacker, system crash

MATHEMATICS

Boolean algebra, arithmetic coding, statistics, equation, Euler totient function, operand, sum, integer, exponentiation, prime number, factoring algorithm, parameter, primitive constant

SECURITY

risk, intrusion prevention, fire protection, contingency planning, privacy, classified information, sensitive information, deterrent, surveillance, authorisation

COMPUTER SECURITY

multi-level security, asynchronous attack, privileged user, ciphertext, deciphering, data diddling, digital signature, exhaustive attack, hot

site, identifier

BUSINESS

transfer of funds, personnel, accounting,
manufacturer, responsibility, cost-effective,
overhead, audit, asset, resource, scenario, check
list, policy, manager

LAW

Data Protection Act, legal requirements, register,
illegal, unlawful, national security, apprehend,
license, enforce, penalty, damages, fines,
imprisonment, compensation, provisions

LINGUISTICS

vocabulary, term, basic terminology, fundamental
terms, jargon, definition, dictionary definition,
glossary, variance in common usage, to mean,
phonetic password, letter frequency in English

Without labouring the point, a number of sense
relations can easily be identified, eg.:

opposites (similar - different, problem-
solution, encryption - decryption);

cause-effect (fire - disaster, negligence -
product defects);

synonyms (bulletin board - electronic bulletin
board, personnel screening - background
investigation, MAC - message authentication code);

near-synonyms (encryption - enciphering);

taxonomy (power protection: line monitor,
voltage regulator, uninterruptible power system,

surge protector, filter, grounding);
 word family (protect - protector - protection,
circuit - circuitry);
 semantic field (information-tapping, direct-
connection tapping, passive coupling,
electromagnetic energy interception, fiber optics
tapping);
 associative/ collocational relations
(malicious attack, salami attack);
 associative cluster (intruder - theft -
barrier - alarm - password - secure - sensor -
disgruntled employee)

Having explored the vital issues of knowledge and
language which impact upon our research, we now turn
to the question of how knowledge - and knowledge of
computer security in particular - is to be
communicated and accessed: the knowledge transfer
question.

Chapter III

Access to domain knowledge

A. Knowledge transfer

1. Encoding of knowledge in texts

When considering the process of textual knowledge transfer, we have to start with the writer's choices and limitations. The process of writing has been shown to differ from one individual to another (Hayes & Flower, 1980). It is rarely a linear process, so that although sub-processes may be identified, they do not fit into a stage model: planning, producing, and reviewing take place in a recursive mode. Nevertheless, it is possible to distinguish between the process of producing ideas, and the process of producing text for those ideas (eg. Collins & Gentner, 1980). According to Sharples (1985), who refers to the work of Cooper and Matsushashi (1983), the writer generates alternative text forms at the sentence level, and subsequently selects one form - this is then verified and optionally transformed. It is at the sentence level that words and grammatical forms are chosen. The writer must juggle a very large number of constraints: applying critical judgement to the selection of ideas in accordance with a communicative purpose, adhering to the linguistic conventions of written discourse, maintaining connective flow and consistency of style, structuring at paragraph, sentence, phrase and word levels, maintaining grammatical and semantic

accuracy, and so on. The experienced, or "advanced" writer, is likely to make subsequent revisions to a text, checking for errors such as structural faults, repetitions, ambiguity, missing context, and inconsistencies, while less experienced writers will tend to check spelling, grammar, punctuation, and make small additions or deletions (Faigley & Witte, 1984).

The choice of words and terms is therefore embedded in a complex process of selection and "juggling". James Hartley (1985), in his book on designing instructional text, makes several references to the conscious selection of words for a target text. Word length is mentioned ("it is easier to understand short familiar words than technical terms which mean the same thing", however "some long words, because of their frequent use, are quite familiar, eg. communication"), word type ("concrete words and phrases are shorter and clearer than abstract ones"), and ambiguity resulting from excessive use of abbreviations and acronyms. He writes about the option of using readability formulae to check the suitability of a text for a given reader age group, and gives examples of "simpler wording" from "The Good Forms Guide" published by the Department of Health and Social Security (eg. "demonstrate" = show; "commence" = begin; "discontinue" = stop, etc. - *it is worth noting that simpler forms can be longer*, eg. "overleaf" = on the other side of this page). Joan van Emden (1990), devotes a section to vocabulary choice (with notions of accuracy, synonymy, precision, confusion, clichés, jargon, "simple language", American English) in her book on writing for engineers, and counsels her writers: "Use words which the reader will understand" (van Emden, 1990:22). She points out an insidious danger

in the use of technical language: "... the reader may assume that he understands and the writer may assume that he is understood. Both may be understanding different meanings." (van Emden, 1990:18). Charles Sides (1984), cautioning about the use of jargon in papers and reports on computer technology, says this: "... the issue of jargon is audience-dependent. Always use what the audience will understand" (Sides, 1984:5). This is sound advice, yet on reflection, it is so cursory that it is doubtful whether it can genuinely be followed. The writer can strive to get to know the audience, and even think about providing definitions or a glossary, but there is still the matter of knowing how to select or adapt one's "jargon". Use "fewer and simpler words", advises Sides, referring to S.T. Coleridge as an authority on the matter. The problem is that knowing which words are simpler is not simple. Some authors giving advice on writing computer documentation (eg. Browning, 1984) use the word "jargon" to designate writing which lacks clarity for reasons other than the use of unfamiliar terms (eg. poor sentence structure which is only confusing to a non-specialist); others (eg. Stuart, 1984) make hardly any comment at all on the use of language. Derek Rowntree, Professor of Educational Development at The Open University, notes the different meanings of "jargon" and gives designers of self-instruction materials detailed practical advice on how to avoid it and how to use it when necessary, mentioning the need to cut out "surplus" words, use short, familiar, precise words, strong, active verbs, and to use specialist vocabulary "with care" (Rowntree, 1986:211-232). With all these authors, the emphasis is on "simplification".

Given the complexity of some forms of technical

discourse, graphic or diagrammatic representations may sometimes be used to complement or replace the written word. Sentential representations, expressed in natural or formal language, are essentially sequential, corresponding to propositions in a text or to a list, whereas diagrammatic representations, organised by location in a plane, naturally express topological or geometric relations. Diagrams also automatically support a large number of perceptual inferences (Larkin & Simon, 1987). Of course, the value of a diagram is dependent on the ability of the individual to interpret the diagram; in certain cases, that ability can be developed by training.

In terminographical analysis, the graphic symbols used to represent various relationships between terms are borrowed from mathematics (eg. $>$ symbolises 'smaller intension') or devised specifically for terminographical work (eg. $>-$ symbolises 'part'). Elaborate systems of concepts can be represented graphically by various tables, charts, and diagrams. Typical representations for logical systems are tree and chain diagrams, rectangular or circular field diagrams, grid tables, and numbered or coded schedules of various kinds. Systems which classify subjects rather than concepts (eg. documentation thesauri) can be based on a terminographical analysis using rectangular or circular "arrowgraphs" - graphs with arrows linking related subjects. While these representation means are "pretextual" in the sense that they are part of a process of analysis which might precede the composition of a text on a given subject, it is worth noting the strong underlying need for graphical representation - it suggests that linguistic symbols are not enough. The challenge, then, is how to "map" diagrammatically analysed

conceptual and terminological data onto a sequential text describing those concepts; or alternatively, how to integrate graphical representations with running text. As this is not strictly within the scope of our investigations here, the reader is referred to the body of research which deals with the comparison of visual and textual means (eg. Kolers et al., 1979; Bernhardt, 1986).

2.Textual communication of knowledge

If composing a specialised text were merely a matter of expression and not communication, then it would be enough for the writer to find the most apt means of expression at any given time. In reality, the writer must direct his or her writing towards a reader. In a situation of dissemination, regard for the reader may not be as crucial as it is in a situation of tuition by means of texts. On the one hand, we have one-way delivery, in articles and books, with the reader permanently at the receiving end. On the other, there is actual or simulated two-way communication, as in distance learning or self-instruction materials, where the reader is expected to play a more active part in the communication process, if only by "regurgitating" material to prove that it has been read, or by elaborating the knowledge structures of the text through the addition of elements of his or her own knowledge and experience.

At this point we have to confront head-on the problems of knowledge transfer through texts. The constraints of such transfer are obvious: limitation of scope, necessary selection and prioritisation of ideas, difficulty in tailoring material to an

individual reader's needs and in providing feedback on progress or understanding. As a learning situation, textual transfer lacks the personal human factor, the possibility of thrashing out meanings in the course of interaction. Well designed self-instruction materials "must carry out all the functions a teacher would carry out in the conventional situation - guiding, motivating, intriguing, expounding, explaining, provoking, reminding, asking questions, discussing alternative answers, appraising each learner's progress, giving appropriate remedial or enrichment help ... and so on", writes Rowntree (1986:11), but even with tutor back-up (eg. by correspondence) it is not possible to emulate the immediacy of the face-to-face situation. There is also the loss of control by the provider of knowledge (the writer): a reader cannot be compelled to read in sequence and in totality, from beginning to end. It follows that from the point of view of language understanding, a term may be received "out of context" - without a preceding context which might have served to clarify its meaning. This is especially true of technical and user manuals, which are more likely to be read out of sequence. The effectiveness of knowledge transfer is then potentially compromised.

As a counterbalance to these limitations and drawbacks, there are the conventions of technical discourse which invite, if not actually prescribe, elucidations in the form of illustrations, examples, definitions, and glossaries. A further potential advantage of textual communication over the spoken medium is the reader's ability to go directly, without preamble or digression, to relevant information - providing that effective mechanisms of access (eg. index, headings) are in place.

Several problems associated with the use of terminology in the process of communication deserve to be highlighted here. Problems of inconsistency and inadequate standardisation are fairly well known, as are the challenges of choosing an appropriate technical level. What has not been explored sufficiently so far is the relationship between a specialist's discourse, with its relatively high density of terms, and a layman's discourse, which must contain fewer, as well as different, terms. In a situation where the layman asks questions of the specialist (whether directly or through text), it is likely that the layman's discourse will contain whole phrases which map onto single terms in a specialist's more compact terminology. If, as we know, nominalisation is a feature of specialist discourse, we must ask how that relates to the necessarily more verbal character of the layman's language. We must also ask how we should deal with the vagueness, uncertainty, and fuzziness of general language. Interestingly, an expert explaining his or her subject will use belief words like "possible", "probable", "likely", "certain", etc. and value words like "fatal", "serious", "dangerous", "undesirable" (Hart, 1989), but texts are more definitive and more authoritative in nature - they strive to freeze the results of experiment or thinking - so words like these are less likely to figure. But just as they figure in the mind of the specialist, so they are a feature of the layman's thinking - and also the layman's questioning discourse. The disparity between speech and text in this matter is particularly visible in texts of an explanatory or instructional nature, where the specialist (author) must not be seen to waver.

Solutions to the problems of specialist-layman communication have been worked out in a variety of approaches ranging from the prescriptive (eg. Basic English, controlled English, terminological standards issued by the International Standards Organisation and its national equivalents, authoritative dictionary definitions), to the descriptive (explanation by example, analogy, synonymy, paraphrase), from the analytical (breaking down complex notions and procedures into constituent elements and steps) to the synthetic (abstracts, chapter summaries). But even if material is in itself well explained, how does one ensure that the reader gains access to it in a lengthy text ?

3.Expression of knowledge needs

It has been said that "as a necessary condition to satisfying the need to obtain information, we must be able to formulate our informational needs" (Wessel, 1975:4). The formulation of needs in the form of questions is a skill which can be developed (Kukulska-Hulme, 1988), and it is also the most widespread, natural way of obtaining information. The ultimate goal of information retrieval from a computer manual is not merely to extract information, but to gain understanding, and to do something with the knowledge gained - to act in an informed way. "Comprehension is less a matter of being able to reproduce the facts in a text than of what one does or is able to do as a consequence of interacting with the structure of the text." (Smith, 1982:65). The success of information retrieval in terms of comprehension and action depends on the questions that an individual asks. This fits in well with the 'function-content' approach to cognition

favoured at Yale (Galambos et al., 1986), where the emphasis is on the content of cognitive activities - motivation, plans, goals, and outcomes -, and on function - how content will be used subsequently in tasks. In this light, we can view retrieval as a goal-oriented cognitive activity related to real world tasks.

If we recognise that retrieval is related to subsequent action, this may be sufficient grounds to cast doubt on the prevalent tendency in information retrieval to discount verb forms as descriptors in favour of nouns. The practical advice proffered by information scientists for the control of thesaurus terms has for a long time been:- "Terms should be in noun form, and verbs should be avoided" (Aitchison & Gilchrist, 1972:14). The reason for this advice could be that it is necessary to match retrieval terms to terms in a body of specialised texts, which are seen to be predominantly nominal. But if we shift the focus from text to user, we are faced with the possibility that needs might be centred on verbs if they are concerned with action. The same authors state that "... terms arising from questions likely to be put to the system are as important as those taken from the literature ... The questions should be collected from users or from records of questions already encountered" (Aitchison & Gilchrist, 1972:69). Consequently, we might have to work out the relationship between verbs and nouns in this specific situation and in relation to the specialised domain. As will be seen, this is an issue which was very much at the forefront of the terminological investigations reported in later chapters.

4. Access devices and reading skills

In order to fully appreciate the scope and limitations of retrieval, we have to consider the strategies available to readers. In a conventional manual or book, there are a number of typical entry points to texts. Rowntree (1986) gives a useful rundown of these "access devices" in materials destined for self-instruction: *explanatory title, contents list, concept map/flow diagram, list of objectives, introduction/overview, links with other "lessons", (numbered) headings, instructions, verbal (rhetorical) and visual (typographic) signposts, tests, summaries, glossary, index*. To those access devices may be added *keywords and illustrations* (charts, tables, graphs, maps, drawings, photographs, diagrams). However, this list does not necessarily represent what is normally found in manuals; in addition, manuals may be destined for reference rather than tuition or self-instruction. Browning (1984), writing about software manuals, points to the other side of the coin: even if you are writing a manual for reference, "your readers could be technicians or students trying to learn from your manual because it is the only documentation available to them" (Browning, 1984:27). She then has this to say about tables of contents: "Readers scan the table of contents once and then promptly forget it exists, turning to more important things like the index" (Browning, 1984:99). In her view, the table of contents is mainly a way of helping the writer to organise a text and to ensure that all information is included. Indeed, it would seem that in reference works the index is a more important access device. Peter Hansjörg, a Swiss barrister concerned with making legal texts (pertaining to environmental

legislation) more readily accessible to those outside the legal profession, writes this about one such document: "Ce sont des non-juristes qui vont le consulter et qui chercheront dans l'index. Il faut tenir compte de ce fait et prévoir un grand nombre de mots-clés qui satisfassent aux attentes des non-juristes" (Hansjörg, 1992:35). So what items should go into an index ? According to Browning, "important" words or phrases, and "not only words that actually appear in the text but also related words or synonyms that might be significant to readers" (Browning, 1984:115). In an otherwise perspicacious book which rightly emphasises the importance of indexes, the vagueness of this well-meant advice is all too apparent.

Knowledge retrieval is also dependent on reading skills and strategies, including identification cues to do with text type and language processing heuristics (word recognition, syntactic/semantic cues, anticipation), skimming and scanning of larger chunks of text, and the ability to follow links or references. It may be supported by note-taking and shorthand skills, and the use of dictionary reference tools for decoding. It is related to motivation, thinking and reasoning processes. According to Hart (1989), risk is extremely important in reasoning: "A low probability high risk situation might warrant investigation before a high probability low risk one" (Hart, 1989:111). Risk could be a significant factor in the selection of knowledge for retrieval; in the domain of security, a preoccupation with risk is practically self-evident. Retrieval is thus part of a larger process of real world problem-solving. Nowadays, problem-solving strategies are considered to be domain-specific rather than general, with problem-solvers

moving between detail and overview in an arbitrary fashion. It is not possible to predict exactly how a text will be used for problem-solving, but both detail and overview may be required.

5. Knowledge assimilation

We are constantly reminded of the nature of retrieval as a recurring event in a process of knowledge acquisition. On the one hand, "understanding...is necessarily based on what we already know of the world" (Abbott & Black, 1986:123) - prior knowledge being used to connect related elements, create explanations, make predictions, ignore irrelevancies. On the other, the results of retrieval must be assimilated into and alter existing knowledge structures. Factors which come into play in understanding and learning include motivation, learning strategies and learning ability. Gagné & Briggs (1979) point to the different varieties of learning in schools: intellectual skills and strategies, information, attitudes and values, motor skills. The success of learning depends in part on the accurate definition of learning objectives, and the same authors draw attention to the need for precise language in the definition of objectives: for instance, choosing verbs carefully to describe specific intended capabilities (eg. "discriminate", "identify", "classify") and actions (eg. "match", "name", "define"). Readers of manuals define their own objectives (- not always a crisp definition), and their problem-solving situation provides the motivation for learning.

6.Computer security: knowledge transfer problems

Earlier, we introduced the idea of 'knowledge-building', a process of knowledge acquisition and assimilation. Fig. 2 illustrates the development of knowledge; an individual may, however, tread a different path, starting with experience rather than theoretical or formal knowledge, and in some disciplines observation is the starting point.

The essential problem of knowledge transfer through specialised texts is that the reader (novice, learner) is trying to 'tap into' the expert knowledge of the author, not having gone through the process leading up to expertise. In other words, the reader is seeking a shortcut to expert knowledge, but at the same time is experiencing uncertainty and needs opportunities to relate new knowledge to experience and to prior knowledge. A pedagogical or explanatory text will recognise these needs, but a reference manual (or a manual which assumes a certain level of knowledge) will not. This is potentially a problem. A reader's knowledge needs will reflect uncertainty and gaps in knowledge. How is this to be mapped onto the confident expertise reflected in the text ? The answer must surely involve both knowledge and language.

The domain of computer security brings with it certain additional problems, which can be summarised here:-

- problem-solving orientation: knowledge is closely allied to action, so must in turn be 'translated' into action

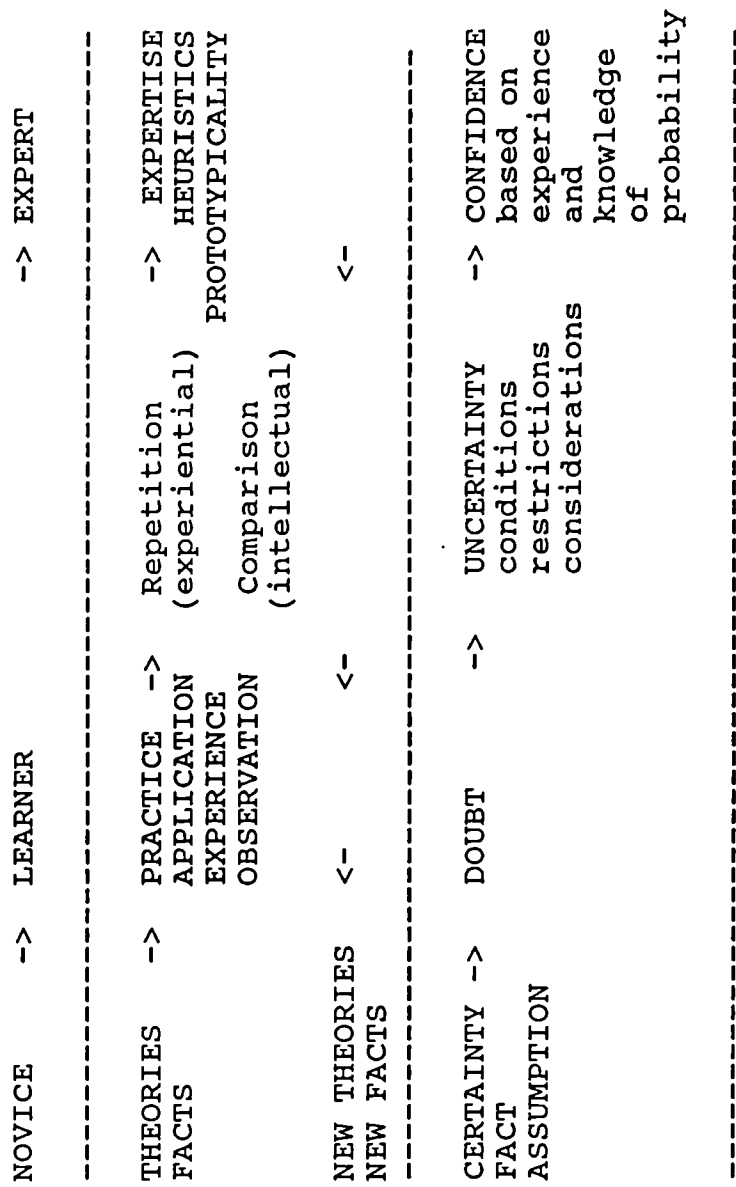


Fig. 2 The development of knowledge

- abstract notions (abstract language) for strategic planning coupled with practical knowledge (concrete language) for implementing plans
- relationship to a wider operational context: legal implications, and people (human resources), combined with an introspective complexity: technical and mathematical concepts
- wide range of knowledge types and wide scope of general and special reference, with ensuing need for varied methods and language variety in knowledge transfer
- terminological instability: change and growth, with a lack of consensus on the meaning of some terms
- terminological obscurity: currency of acronyms (UPS, EFT, STK, ESD, CSMA, ...) with attendant dangers of mystification
- general applicability of computer security concepts (implied by handbooks) versus the need to relate these to specific computer systems, specific configurations, specific computer functions

B.Computer environments for knowledge transfer

1.Features of computer-assisted transfer

It is hardly possible to conduct research into the terminological design of computer manuals without stressing the point that, with every year that passes, more and more documentation is accessed on the screen rather than on paper. According to McGrew & McDaniel (1989), in their introductory work on on-line text management, an "on-line text access system" can be

"any type of on-line information system. It can refer to on-line help for a specific application, a computer-aided instruction course, or the software used to develop such a course. Or, it could be an on-line system for retrieval of the type of information traditionally found on paper, such as user manuals and reference documents."

(McGrew & McDaniel, 1989:3)

Access can take place in a "free-standing" text environment, or one that is "context-sensitive" - that relates information to the task at hand. Documents can have a traditional, linear organisation, or be structured in a hierarchy or a network, or have associative links; "hypertext" techniques can use all these options. *Hypertext systems* embody object-oriented documenting, i.e. document elements such as words, phrases, sentences, or paragraphs become objects which can be linked to other objects, giving the user access to related topics. *On-line tutorials* are usually "constructed so that the user is guided from topic to topic in a directed manner, building on the knowledge presented" (McGrew & McDaniel, 1989:78); this is a form of *computer-based instruction*, though the latter term normally refers to systems which are

interactive in nature. There are also *intelligent tutoring systems*, which "adapt to the learning style of the student, providing guidance, instruction, and support in performing complex tasks" (Alberico & Micco, 1990:17). Although the availability of associative navigation can mean that access to information is freer, if document signature (full text) indexing is used, many *noise* references can result.

The nature of human language is such that there are numerous problems associated with keyword-based retrieval and with the automatic processing of text for indexing purposes; Smeaton (1992) has discussed these in an article on the application of natural language processing to information retrieval tasks. In essence, the problems revolve around the basic property of natural language: ambiguity. We made reference to ambiguity earlier, in relation to the identification of knowledge types in text, and now we revisit the problem in relation to computerised retrieval, since automated processing actually amplifies the problem. The culprits are ambiguous words, as well as structures, for instance prepositional phrases, nominal compounds and various forms of conjunction; discourse level ambiguity is also a problem. Nonetheless, progress is being made in improving information retrieval, with the application of techniques such as *conceptual information retrieval* (eg. Wyllie, 1990), *statistical term weighting* (where the likely senses of a word are weighted highly), and *knowledge-based machine indexing* (Genuardi, 1990). The challenge, then, is to design text retrieval systems which genuinely help the user, and do not provide an excessive amount of information, some of which is scarcely relevant. This is where *expert systems* for

information retrieval come in, with their aim of augmenting or emulating the expertise of the intermediary.

Computer-assisted knowledge transfer systems share many of the common linguistic problems which affect all modes of knowledge transfer, but in cases where linguistic sensitivity is all-important - for example, communication between a specialist and a layman - the computer environment is at a definite disadvantage in comparison with person-to-person contact. We must therefore continue to look for ways of describing and emulating human linguistic awareness and skill in responding to the special needs of "special language" (language for special purposes, scientific, technical language) communication. Applications will abound: for instance, in the domain of computer security, Cooper (1989:362) projects a need for "efficient and effective training aids (such as automated interactive systems)".

2.Existing systems for knowledge transfer

It is worth pointing out that, alongside sophisticated, intelligent tutoring and retrieval, knowledge transfer can be enhanced by reading and writing tools which do not necessarily form a complete system, and may have little programmed "intelligence". It may be a question of giving writers feedback about the quality of their technical writing in terms of its "readability", its organisation, grammar, style or vocabulary, based on pre-conceived rules and statistical analysis. In this section, we give a brief description of a selection of different systems and research projects

which have some relevance to the line of enquiry we are pursuing, in order to give a flavour of the variety of possible approaches.

David E. Kieras, at the University of Michigan (Kieras, 1981-87; Mayer & Kieras, 1987; Britton & Glynn, 1989), describes an advanced computerized aid for the writing of comprehensible technical documents resulting from a long-term project supported by the Office of Naval Research and aimed at improving military equipment manuals. The system is designed to help writers in improving the clarity of their writing. It is assumed that both writers and readers have the necessary background knowledge, but both lack "reading skills". The system, based on research in comprehension, aims to help the writer to edit his or her text by detecting problems specified by rules relating to reference, sentence structure, and textual coherence. In a similar vein, J.P. Kincaid (Kincaid et al., 1981) reports a Computerized Readability Editing System (CRES) intended for military (naval) texts. This writer's aid also gives feedback about the quality of writing. Output from the system is an annotated copy of the original document pointing out stylistic problems, non-standard terms, and giving a Kincaid-Flesch readability score.

Bell Laboratories (Macdonald et al., 1982) are where the more generally applicable Writer's Work Bench (WWB) originates. It provides global statistical information about a document, including scores for several readability formulas, part of speech statistics, sentence lengths, and statistical comparison with "model" texts. At the University of California, Morton Friedman's system, WANDAH, (commercially published as 'HBJ Writer'; Friedman,

1987; Britton & Glynn, 1989), is designed to assist student writers in all phases of writing (planning, transcribing ideas, revising). Based on research by Hayes and Flower, the planning aid prompts the writer to reveal purpose, identify audience, and outline ideas. The revising aid addresses problems of grammar, style, and thematic organization; it can highlight specific stylistic features of the text (eg. abstract words, transitional words and phrases, pronouns), and will produce an outline based on the first sentence of each paragraph, or sentences selected by the writer. An innovative project in Computer Assisted Writing Techniques has been reported by Jeannine Beeken (University of Leuven; Beeken et al., 1990). This addresses student and business writing, with two basic components - a questioning procedure (or predefined text-frames for business writing), and a "thesaurus" (system of lexicons) comprising collocations, functional & text-cohesive items (eg. expressions of consequence, concession, comparison, etc.), normative information about lay-out, typography, spelling and grammar, systematic technical terminologies, advice on text structure. The system will include visual tree diagrams of selected text structures, where nodes can be amended through a 'zoom-in' facility. Reading, writing, reference manuals, online help/documentation and distance learning are all applications envisaged by Victoria A. Burrill, University of Reading (Burrill in: Van Vliet, 1986) for her system, VORTEXT, which tries to map the design of a paper book onto the computer screen, with an open page in the centre and closed pages either side (with headings). This gives the reader orientation within the system and within the subject matter. Text can be concorded and headings indexed, and speed of text presentation can be varied.

Moving on to a system concerned with question-answering based on knowledge from texts, Boris Katz (AI lab of MIT; Katz, 1988) has reported START, which analyzes English text and automatically transforms it into a formal representation (the 'knowledge base'), incorporating the information found in the text. The user can query the knowledge base in English, and the system's response is also in English. It has been used in a number of domains, including medicine, politics, space (Mars observer mission), vision, common-sense physics. An example of an intelligent aid to bibliographic information retrieval is the Austrian SAFIR (Smart Assistant for Information Retrieval; Brückler et al., 1988), a system with a user interface which adapts to different user levels and provides "sufficient help" when needed; it has a single command language which translates into different host languages; online information about hosts and databases; and a domain knowledge base with knowledge acquired from the user (including a record of all search histories), used for defining the model of the information need.

Alberico & Micco (1990) describe a system by B.C. Vickery & H.M. Brooks (PLEXUS - A Knowledge-Based Reference System) which represents knowledge about terms and concepts related to gardening; the sources of knowledge are printed reference works, human experts and gardening associations. Using PLEXUS, which has a natural language interface, involves matching terms in queries to terms in its dictionary. Another expert system for bibliographic retrieval has been developed by Gauch & Smith (1993), focussing on (Boolean) "query reformulation" (eg. broadening, narrowing, changing query structure) resulting in improved efficiency. Bordogna & Pasi (1993) propose the use of linguistic

descriptors to specify the degree of importance of terms, in preference to more traditional numeric query weighting.

Ingrid Meyer, Doug Skuce et al. in Ottawa (Research Grant Request, 1989; Skuce, 1993) have developed a knowledge-based approach to conceptual description in terminology, based on Meaning-Text theory, and using CODE, a generic conceptual analysis tool, with graphical representation of conceptual relations. Ivar Utne (Utne, 1987), at the Norwegian Term Bank, describes a terminological databank system which has, apart from a "conventional" thesaurus, conceptual networks of static and procedural information, represented in frames and schema. Frames include the relations 'part of', 'cause', 'sequence', 'connected to', etc. and various attributes (colour, shape, etc.); the procedural schema contain information on events/actions (eg. verb with related roles: agent, object, place, result) and on series of events or actions.

There is also a rich body of literature reporting research and development work on computer-based learning and intelligent tutoring systems. An interesting experiment has been carried out by Ford & Ford (1992) at Sheffield University, where a simulated expert tutoring system was used to find out about learning strategies; a qualitative analysis of learners' question data relating to the Precis package revealed 11 categories of question, grouped into four general categories, and four levels (general to detailed), which could be used to predict more and less successful learning strategies.

Further information on the fast growing fields of

computer-aided reading and writing, intelligent computer-aided instruction, intelligent retrieval, and knowledge representation systems which in one way or another facilitate knowledge transfer can be found in a wide range of periodicals, for instance "Intelligent Tutoring Media", "Online Review", "The Electronic Library", "Advanced Information Systems", "Interacting with Computers", "Information and Software Technology", "Journal of Artificial Intelligence in Education", "Expert Systems", "Computers and Education", "Machine Learning", "Instructional Science", "User Modeling and User-Adapted Interaction", "British Journal of Educational Technology", "Information Processing and Management", and others.

3. Searching on the IBM AS/400 system

The possibility of electronic searching on the AS/400 has been mentioned earlier; here we must pause to consider the "search index" and "BookManager" facilities from a terminological perspective. The "search index" option on the system may work well for a very experienced user, but for someone less experienced or with little knowledge of security, there are problems:

(a) the system's ignorance of orthographic variation,

eg. 'backup' yields a list of topics, the first of which is 'Backup guidelines';
'back up' yields the same list, but without the guidelines;
'backups' yields nothing at all.
A user who types 'back up' and 'frequency' will not get the guidelines, which deal

with frequency of backups.

- (b) appropriate terminology expected,
 - eg. 'confidential mail' and 'personal mail' are acceptable, but 'other peoples' mail' is not (as in the query: "Can I look at other peoples' electronic mail ?")
 - eg. 'hack'/'hacker'/'hacking' are not known to the system
- (c) accurate terminology expected
 - eg. An answer to the query "Is there a way to display all commands that a user has *authority* to ?" is provided by the 'display user *permission*' command, not the 'display *authorized* users' command, which is potentially confusing.

The last example also shows how prior knowledge is presupposed. Faced with a list of topics as a search result, the user has to choose from that list, and so must have an idea of what each topic is about. The search facility cannot deal with conceptually complex queries (eg. "Can users be automatically deleted if they do not sign on for X months ?"; "Can a user 'passthrough' to another system and gain greater authority than he has on the original system ?"); it cannot deal either with knowledge not represented, eg. the AS/400 is apparently immune to virus attacks - but users, not aware of this, may still wish to ask about this potential hazard. The search index appears not to know about viruses.

The BookManager retrieval software for the CD-ROM version of the security manual, despite many excellent features - including a sophisticated ranking facility (by location, frequency, exactness,

uniqueness, sequence similarity) - , shows weaknesses similar to those of the help index. For a novice user, or one unfamiliar with security concepts and terminology, attempts to use 'everyday' words as search terms will prove futile: items like 'disaster', 'illegal' or 'piracy' result in no matches at all. A "word check" can be performed before searching, and will show words with similar spelling, but offers no thesaural or other substitution (eg. for 'right' it does not offer 'authority' or 'permission', etc.). So far, the search facilities available have not addressed, much less resolved, the terminological knowledge transfer issues which are the subject of our research.

Chapter IV

Empirical study - the reader's perspective

A.Reader survey

1.Objectives and method

In order to find out more about the relationship between the natural language used to express knowledge needs in the area of computer security, and the language of computer manuals, it was decided to establish a corpus consisting of questions formulated by users, which could be analysed subsequently from a terminological and knowledge type perspective.

The corpus data was collected by means of a survey. Gathering truly 'natural' language data is always a very difficult undertaking. It was important to give the user the opportunity to express queries spontaneously, without, as far as possible, having undue constraints as to content or form. This is different to taking data from an on-line (or telephone support) query answering service, where answers are provided by either people or computers, in that an initial filtering process would have already taken place - eg. a user turning to the support service *after* other avenues (colleagues, manuals) had been exhausted - whereas a survey could capture queries as soon as they arose in the mind of the user. Admittedly, asking a user to write down a number of queries (for the survey) is in some way artificial. Firstly, in real life situations,

queries are not always uttered: some remain at the stage of thought, in which case their form cannot be described reliably - it may not even be linguistic. In a linguistically-oriented project, it is not possible to deal with such data. Secondly, it would be excellent if queries could be captured as and when they arose, over a period of time, in various circumstances; such an ideal, however, cannot be achieved without considerable input from a truly dedicated (yet large enough) group of users.

As users of the AS/400 will, in principle, have access to manuals, we can also refer to them as "readers", where the term is understood to denote "actual and potential readers". Clearly, it would be wrong to suppose that reading a manual could ever provide the answers to all queries. There are bound to be questions which will not be answered by the manual, for reasons of scope as well as the knowledge representation problems which have already been discussed. However, a reader cannot be expected to know or accurately judge whether or not a particular query can be answered in this way. This is why it is important to submit all queries to analysis, without prior filtering. Having said that, the survey respondents were then asked to indicate where they would expect to find the answer to each query - so that a link between query type and manual consultation could be established and explored.

It was decided that a user's level of knowledge would be established by asking about professional experience, knowledge and experience of computers in general and of the system in particular, in addition to knowledge of computer security. Users were also asked about their use of a number of different information sources on computer security, and in the

main part of the survey (hereafter referred to as Section II), they were instructed to write down, as they would "spontaneously say them", twenty questions they "could ask or could be asked" about the security of their computer system.

The self-completion questionnaire (Appendix I) yielded a corpus of 334 user questions (hereafter referred to as "queries"), representing 3,586 token words. The number of queries supplied per user ranged from 20 (in 6 cases) to 0 (in 1 case), with an average of 9.8 queries. The questionnaire had been distributed to a sample of 76 users known to have some responsibility for security on their AS/400 system. Attempts to obtain further lists of AS/400 users from sources such as IBM, the AS/400 Computer Users Association, several IBM agents, and the NCC in Manchester - despite initial good will - proved futile. The problem appeared to be two-fold: firstly, the desire to protect data held on computer files (not wishing to provide names and addresses where there was uncertainty about users' consent - a case of good security practice !), and secondly, the nature of the domain of computer security - peoples' reluctance to risk revealing gaps in their knowledge of the subject, despite an assurance of confidentiality. However, the main thrust of the research is not quantitative (how many users), but rather qualitative (how are needs expressed).

The response to the survey, after a pilot phase and telephone reminders, was 34 returns, a response rate of 44.73 %. Written and telephone comments from both respondents and non-respondents revealed several reasons for non-completion: (1) time pressures in the business environment, especially the time required to think of 20 queries, (2) a reluctance to

acknowledge a degree of responsibility for security, where it was not unequivocally allocated, (3) a feeling of knowing too little about the subject - inability to think of 20 queries, (4) knowing too much about the subject to think of questions, or already having well-established security procedures, (5) long-term illness (in 2 known cases), (6) user of PC's only (in 1 known case), (7) (speculative) fear of being "shown up" - gaps in knowledge.

2.Reader profiles

The survey was addressed to AS/400 users, with a covering letter explaining that it was aimed "particularly at less experienced computer users", though users with more experience were not excluded. Typically, it is inexperienced users who have the most problems finding information, and the greatest fear of manuals. No age, sex, or professional status criteria were imposed. The users surveyed were based in a number of different business companies; completed returns were from users in professional firms - chartered accountants, and software development (the majority being in these two categories), and in manufacturing/ distribution. In these companies, the AS/400 was known to be used for business, administrative, manufacturing and software development purposes. Geographically, the companies were located throughout England and Scotland.

The results of the survey showed that all respondents considered themselves to have some knowledge and experience of computers. In each of the four categories specified (*i.e. knowledge and experience of computers in general; knowledge of the AS/400 operating system; of computer security in*

general; of security on the system), around half (47% - 53%) described their knowledge as being "good". In the majority of cases (85%), respondents' knowledge of computer security in general was described as being either good (47%) or limited (38%), and knowledge of AS/400 security was mostly good (47%), but also very good (32%), limited (18%), or very limited (3%). As regards job titles and professional experience, 18% had a job title not directly associated with computing (eg. Secretary, Partner), although in one instance the respondent had a computing background. Of the remaining 82%, 29% had no previous professional experience in computing. Currently held computer-related positions ranged from administrative/ clerical to managerial (project manager, product manager, technical director), and included programming, analysis, operations, and support.

It is interesting to speculate that it may be very hard indeed to find users with no previous knowledge of computer security whatsoever, if we consider that: "Fire and smoke detection alarms are familiar to most of us because of the availability in recent years of low-cost home devices. The technology for computer facilities is similar" (Cooper, 1989:80).

B. Analysis of readers' needs

1. The language of queries

a. Lexical and terminological analysis

A lexical and terminological analysis of the query data in the survey (Section II of questionnaire) was undertaken in order to study the word types

occurring in the data in relation to knowledge needs. The overriding objective was to piece together, by observing the data from a number of complementary angles, a picture of the knowledge needs expressed through different linguistic elements and devices.

The analysis was begun by segregating words into grammatical categories. It was decided to leave aside, initially, some grammatical words, thus focussing on truly "lexical" items, referring in this matter to Carter (1987), who makes clear the distinction between "grammatical" words and "lexical" (or "content") words. The items set to one side were articles, prepositions, pronouns, conjunctions, numerals (other than in names or codes), and interrogative pronouns. Interrogatives were subsequently scrutinised in the rhetorical analysis, and other pronouns and conjunctions were also identified as having a role in conveying knowledge needs. Wilbur & Sirotkin (1992) have, in their own way, challenged the traditional notion of "stop words" by removing, for the purpose of improving retrieval, words identified by a vector method of similarity measure.

For the numerous word forms which could represent more than one part of speech (eg. 'access', 'control', 'secure', 'change', 'audit', 'damage', etc.), concordances were run on the computer to check actual usage in the survey data.

(Note: spelling mistakes occurring in the original data have been retained, for instance "to setup" instead of "to set up".)

Noun forms

(Note: many nouns are used adjectivally, eg.
'capital' investment, 'user' ids, 'history' log,
'security' measures, etc.)

access, administrator, advantages, air conditioning,
alarm, amount, application, application's, areas,
arrangements, attack, attempts, audit, auditor,
authorisation, authorities, authority, backup,
backups, basis, batteries, boot, breaches, building,
cabinet, calendar, capability, capital, card,
chances, change, changes, chars (=characters),
checks, checkers, classifications, clause,
colleagues, command, commands, comms,
communications, companies, computer, computers,
consultation, contracts, control, copies, CPU
(=central processing unit), crash, damage, dangers,
data, data base, day, days, default, delay, dept,
desk, desks, detection, detectors, device,
difference, disaster, document, documents, DP(=data
processing), EDI(=electronic data interchange),
electricity, employment, environment, environments,
encryption, event, expansion, expenditure,
experience, extent, facility, faults, field, file,
files, fire, flexibility, folder, folders, force (in
force), freedom, frequency, function, functions,
generations, grades, group, groups, hacker, hackers,
hardcopy, health, help, history, holders, host,
hours, I.D. (=identification), Id's, ids, impact,
importance, individual, info, information,
infringements, integrity, intervals, job, key,
lengths, level, levels, library, libraries, life,
lifespan, light, limits, line, link, list, lists,
log, logs, loss, m/cs (=machines), machine, mail,
management, market, master, measures, media, menu,
messages, methods, modem, month, months, need,
network, networks, number, object, objects, office,
officer, on/off site, options, organisation, output,
outside, overtime, owner, pad, pain, panel,
parameters, part, partner, parts, password,
passwords, payroll, PC, people, peoples', period,
person, personnel, place, places, plan, point,
police, police station, portables, position,
practice, precautions, premises, principles,
printers, problem, problems, procedure, procedures,
product, products, profile, profiles, program's,
programs, proof, protection, quality, queue,
rationale, recovery, replacement, reports,
resignations, response, restrictions, reuse, rights,
rules, safe, safety, saves, screen, screens,
security, set, signon, simulation, site, sites,
situation, smoke, software, solutions, sort, source,
specs (=specifications), spool, staff, standard,
status, steps, suite, supply, switch, system,

system's, systems, tape, tapes, terminal, terminals, theft, time, times, traffic, trail, updates, UPS (=uninterrupted power supply), useability, user, user's, userid, users, value, virus, viruses, water, way, ways, windows, work, workstations, 3rd party

Proper nouns, function names

AS400, IBM, Lotus, FAST (= Federation Against Software Theft), Office Vision, PC Support, QSECOFR, SECOFR, DSPAUTUSR, SYSOPR, QSECURITY

Verb forms

(NB: some past participles of verbs are used adjectivally, eg. 'shared' folders, 'perceived' delay, etc.; some present participles function as nouns, eg. 'training')

able (to be able), access, accessed, accessing, activated, add, affected, allow, allowed, allowing, am, amend, are, aren't, arise, arrange, audited, authorised, authorized, back up, backed up, backing up, be, becomes, been, being, bolt, book, bother, breached, breaching, break, breaks down, build, can, can't, care, catch, caused, change, changed, check, checked, classed, communicating, conceal, conform, connected, considered, contradict, control, convince, corrupted, could, cover, create, cut off, decrease, decrypted, define, deleted, deny, denied, destroy, detect, determine, dial in, disabled, discover, display, displaying, do, does, doing, done, duplicate, educate, enable, encourage, encouraged, enhance, enroll, ensure, ensures, evaluate, exist, exiting, expand, expect, expired, expires, find, find out, force, forget, forgets, forgotten, found out, found, gain, gained, gave, generate, get, give, given, go, goes, got, grant, guaranteed, guard, hack, hacked, happen, happened, happening, happens, has, have to, have, haven't, having, identify, include, increase, indicates, indicating, informed, installed, invoke, involve, is, keep, kept, know, knowing, lead, leave, leaves, leaving, limited, lock, locked, look, looked, looking, lost, made, make, making sure, manipulated, may, mean, might, monitor, must, necessitate, need, needed, offer, operate, override, owns, pass through, passthrough, passing-through, perceived, persuade, plan, preserve, prevent, prevented, protect, protected, put, raid, read, receive, recover, reduce, reducing, reinstate, related, remain, remove, removed, required, restore, restored, restrict, restricted, return, reviewed,

running, saved, secure, secured, see, sees, set up, setup, setting up, set to, share, shared, should, show, shut, sign on/off, signon, signed on, signing on, sit, specify, spread, spreading, start, stop, stored, storing, suffers, supplied, support, suppress, take, taken, tell, tendered, terminated, test, testing, tether, think, trace, training, travel, tried, try, trying, un-manned, updating, use, used, using, viewed, viewing, walk, want, was, will, won't, work, would, wouldn't

Adjectives

adopted, all, any, automatic, available, aware, best, better, breakable, certain, common, complex, comprehensive, confidential, detailed, different, due, easy, efficient, electronic, encrypted, every, existing, expensive, external, first, foreign, free, front, full, general, good, greater, illegal, illicit, inactive, incoming, internal, invalid, live, local, long, magnetic, main, major, many, midrange, more, most, necessary, new, normal, obvious, OK, old, one, organisational, original, other, outside, own, particular, personal, physical, possible, potential, practical, present, prior, public, real, red, regular, remote, resident, resilient, safe, same, secure, secured, senior, sensitive, separate, shared, some, specific, standard, sure, third, total, unauthorised, visible, vulnerable, wrong

Adverbs

again, always, automatically, away, back, best, completely, easily, even, ever, far, frequently, inadvertently, internally, just, last, long, often, once, only, periodically, physically, quickly, really, remotely, still, there, twice

One striking feature resulting from this categorisation is the relative abundance and variety of verbs, even allowing for the nature of the language sample (short, simple sentence forms), and the fact that verbs take on more forms than nouns. This suggests that the needs expressed in the questions are associated with knowledge about actions or events. The suggestion is further supported by the fact that a substantial number of the nouns in the data are derived from verbs and indicate an action or the result of an action (protection, authorisation, restriction, consultation, detection, expansion, simulation, communication, classification, resignation; replacement, arrangement, infringement, employment). In addition, many of the forms occurring as nouns also occur as verbs, or have the potential to function as verbs (breach, damage, delay, function, access, supply, etc.).

When we examine the nature of the verbs used, we can see that most of them express *active control over actions or events*:

prevent	restrict	secure (against)
preserve	change	monitor
protect	ensure	increase/decrease (access)
conceal	make sure	deny (access)
reinstate	detect	remove
shut	start	stop
cut off	force	suppress
identify	delete	destroy
add	activate	amend
involve	include	limit
check	allow	own
lock	review	arrange
give	keep	put
convince	educate	persuade
take	create	enhance
operate	set up	restore
back up	sign on/off	shut down
evaluate	expand	encourage

bolt	connect	tether
man	audit	book
cause	communicate	consider
exit	guarantee	inform
install	invoke	think
test	train	try
view	store	find out
find	enroll	build
catch	duplicate	grant
guard	manipulate	recover
reduce	save	see
override	disable	define
cover	control	generate
authorise	specify	tell
trace	update	want

A smaller number reflect (in the actual data) *observed or anticipated events, or accidental actions*:

hack	break	raid
breach	read	gain (access)
decrypt	access	dial in
contradict	corrupt	travel
tender	pass through	spread
supply	offer	display
show	bother	care
happen	receive	suffer
forget	get	remain
discover	arise	expire
become	exist	terminate
walk	lose	

Some indicate *possibility, advisability, obligation*:

necessitate	be able (can, can't, could ...)
need	have to (must ...)
require	ought to (should ...)

Other verbs are ubiquitous in nature (be, do, have, leave, go, know, make, use, reuse, relate, work, support, share, indicate, perceive, mean).

Passive forms occur infrequently in the data. Where they do, the meaning is often active, for example:

"Can users be prevented from signing on ... ?"

actually means

"Can I prevent users from signing on ... ?"

In terms of frequency, the most prominent verb forms (clustered by meaning) are:

*be is are been being am was
can could can't able
do does done doing
have haven't has having
should*

Two of these clusters signal POSSIBILITY or ADVISABILITY (can and should).

Other frequently occurring verbs are:

*sign on / sign off
change
access
prevent
will won't wouldn't
use
check
find
happen
know
breach*

These reflect the make-up of the total verb list, with a bias towards active verbs.

As the distinction between nouns and verbs can obscure frequently occurring concepts expressed in both forms, and as this can be compounded by variations in spelling, it should be pointed out that the concept of 'backup' has a particularly high overall frequency, occurring in the forms:

back up backup backups backing up back-up
backed up backed-up

When we move on to examine the nouns occurring in the data, the following categories can be seen to emerge:-

ABSTRACT NOUNS OF A GENERAL NATURE

difference, importance, extent, part, way, method, measures, practice, procedure, steps, rules, basis, rationale, frequency, time, hours, interval, period, length, month, reuse, area, place, arrangement, flexibility, freedom, chances, control, principles, pain, situation, change, need, light, force, experience, limits, advantages, set, link, point, sort (of), number, amount, days

NOUNS RELATING TO BUSINESS FUNCTIONS

company, contract, clause, employment, overtime, payroll, staff grades, job specs, resignations, office, department, authority, problem, solution, document, capital, expenditure, information, management, market, simulation, audit, Total Quality Management, work, organisation

NOUNS RELATING TO PEOPLE AND ORGANISATIONS

users, staff, people, person, personnel, group, security officer, master, administrator, auditor, colleague, key holders, hacker, 3rd party, individual, partner, police, FAST, IBM

NOUNS RELATING TO COMPUTING AND COMPUTER APPLICATIONS

system, data, data base, PC, DP, EDI, computer, machine, portables, workstation, software, programs, product, environment, backup, command, folder, menu, communications (comms), device, media, facility, help, library, network, host, site, option, profile, screen, character, calendar, capability, command line, history log, CPU, default, generations, messages, traffic, saves, tape, object, function, application, output, queue, spool, hardcopy, file, field, (illicit) copies, mail, key, update, response times, lifespan, switch, signon, system value, AS/400, Lotus, Office Vision, PC Support, QSECOFR, DSPAUTUSR, SYSOPR, QSECURITY

NOUNS RELATING TO SYSTEM SECURITY

security, password, virus, security level, authority, authorisation, restriction, UPS, UPS expansion, batteries, long life, electricity supply, smoke, water, fire, cabinet, safe, windows, air conditioning, alarm, computer suite, desk, detector,

premises, site, building, fault, recovery, recovery plan, check list, integrity, classification, magnetic card, key pad security, I.D., userid, status, audit trail, access, external source, crash

NOUNS RELATING TO BUSINESS SECURITY

disaster, health and safety, precaution, protection, replacement, right, danger, breach, attack, proof, detection, infringement, attempt, loss, theft, damage, delay, impact

These nouns, many of which change their meaning according to context, have been classified with reference to the contexts in which they actually appear in the data. Even so, the fluid nature of any classification must be emphasised: a computer environment *becomes* a business environment, and words like 'system', 'file', 'message' or 'mail' can no longer be assigned to a single domain. Similarly, a word such as 'signon', though a typical computing term, has special significance when considered in the light of security, and so belongs to both domains. The set of nouns includes computing terms of various degrees of specialisation (with 'help' at one end of the scale, 'EDI' at the other), and security terms which relate to the functioning of the computer system. It also covers business concerns in a wider sense, inasmuch as the functioning of the system affects the functioning of the business, and has particular implications for its staff and for its legal ramifications.

Of particular interest are the abstract nouns of a general nature which provide a clue as to the types of knowledge represented in the data. Two meanings dominate:

And lastly, COMPARATIVE and superlative adjectives are in evidence:-

'greater' (greater authority, greater access)
'better' (better methods)
'best' (best virus protection software, best methods)
'more' (more than one user)
'most' (most common ways)

Adjectives may also be classified in the following categories which mirror the classification of nouns:-

(1) ADJECTIVES OF A GENERAL NATURE

general, comprehensive, specific, particular, detailed, every, some, many, all

(2) ADJECTIVES RELATING TO BUSINESS FUNCTION

efficient, easy, practical, good, OK, wrong, expensive, long, total, complex

(3) ADJECTIVES RELATING TO PEOPLE AND ORGANISATIONS

organisational, senior, aware, own, shared

(4) ADJECTIVES RELATING TO COMPUTING

electronic, magnetic, midrange, main, remote, encrypted

(5) ADJECTIVES RELATING TO SYSTEM SECURITY

confidential, sensitive, personal, public, secure, sure, vulnerable, non breakable, resilient, unauthorised, virus free, illegal, illicit, invalid, physical, full, safe, adopted, visible, red

(6) ADJECTIVES RELATING TO BUSINESS SECURITY

external, internal, outside, incoming, local, major, real

The adjectives relating to business function are largely concerned with the smooth running of the

business, i.e. the best way of implementing security ('Is there an easy way to ... ?', 'What practical steps need to be taken... ?', 'What is the most efficient way ... ?', etc.)

Other adjectives concern

TIMING (including repeating or lasting features)

automatic, regular, prior, resident,
common, standard, normal

POSSIBILITY or NECESSITY

possible, potential, available, existing,
present, necessary

The adverbs again reflect the types of knowledge needs which can be seen to recur in the data:-

TIMING - frequently, often, periodically, quickly,
automatically, twice, long, last, still,
ever, after, before, again, always,
regular (= regularly), then

MANNER/PURPOSE - completely, best, remotely, easily,
internally, inadvertently, back,
physically, so (that)

'Inadvertently' reiterates the hazardous element which characterises computer security.

COMPARISON ('very') and RESTRICTION/ NEGATION ('with', 'without', 'no', 'non', 'not', 'only') can also be identified.

Pronouns and conjunctions

Pronouns are an important feature of the user's discourse: they stand for the nouns the user cannot label, or the knowledge which is only vaguely

defined. Many 'people words' occur in the data in the guise of pronouns:-

everyone, everyone else, anyone, anyone else
someone, no one, everything

Pronouns can be used in the search for knowledge about people and events ("How resilient is the system to *someone* trying to hack their way in ?"; "How do I control *who* sees *what* ?") or a search for a definition of quantity ("How *much* is there on the system I can't even see ?").

Relative pronouns establish relationships between objects and actions ("objects *that* he/she owns"; "a document folder *that* only I can access"; "user ids *which* a hacker could see") and relate timing to events ("every time (*that*) I leave my computer"). Likewise, conjunctions show relationships between elements of knowledge:-

CONDITION/RESTRICTION "if", "if so", "unless"

What do you do if someone's password expires ?
Can viruses travel through networks - if so,
are there resident checks to monitor/ ensure
the health of incoming data/ mail ?
How can I prevent a user from updating an
application's set of files unless they are
using the application ?

OPPOSITION "yet", "but"

Why is spool file security so complex ? Want to
stop people viewing spool yet be able to
control printers.
Can users be given access to commands but still
be 'limited capability' ?

TIMING

"when", "while"

What should happen to the system when the office is un-manned ?

Can we back up security while people are signed on ?

COMPARISON

"than"

Can a user "passthrough" to another system and gain greater authority than he has on the original system ?

COORDINATION

"and"

Can I allow Office users to share a signon I.D. and have separate passwords ?

This lexical analysis of the query data shows that the lexical items used belong to a number of related domains, and it highlights in particular the fact that a high proportion of items are general language words with semi-specialised meanings: the language's internal loan-words, which are easily assimilated by users. Any terminological analysis of the data, therefore, has to be based on a very broad definition of 'terms', as the low technical or specialised content of these items is the very essence of the data.

In trying to establish the range of potential access paths to knowledge of computer security, we have to investigate the links formed between the user's question and the target knowledge base (i.e. sources of knowledge on computer security, such as manuals) through the intermediary of terms. It is accepted that terminological concepts can have a number of

denominations, so that for instance the concept of 'user identification' may be designated by the terms 'I.D.' and 'user id' in their various forms. Similarly, 'back up' and 'save' may be observed being used interchangeably for the same concept. Traditionally, due to the nominal nature of specialised texts, terminologies have been perceived as collections of nouns. It is clear that in the case of users' discourse, other parts of speech play a very important role in conveying knowledge needs.

One could argue, furthermore, that it would be a mistake to try to isolate, at all costs, the lexical and terminological items expressed in users' queries from their connotational and collocational contexts. At the most simple level, this means recognising that, for example, the term 'audit' is connotationally (and paradigmatically) linked to 'auditor', and collocationally to 'audit trail'. It is, after all, very common for terms to constitute "multiword units". But it also means allowing terms to present themselves in their natural *entourage*: "default passwords" will at some stage be "reviewed", "damage" has to be assessed in terms of its "extent", and so on. When trying to establish a valid mapping between questions and answers, we may have to take these larger units into account.

In terms of frequency of occurrence, the top nouns are:-

- security
- system
- user(s)
- password(s)
- access
- data

By the same criterion, two further nouns, "backup(s)" and "authority(ies)", represent very

important concepts, if one takes into account their verb forms (to back up, to authorise); adding synonymous terms ("save", "right") increases their frequency even more.

b.Intentional and rhetorical analysis

An intentional and rhetorical analysis of respondents' queries was carried out in order to discover the knowledge needs of users as revealed by the types of question asked. The approach taken was to examine entire queries (Appendix II), and to create clusters (categories) of queries which appeared to express similar knowledge needs (intentions). Interrogatives such as 'How' or 'What' can suggest corresponding rhetorical questions (who, what, where, how, when, etc.) and knowledge types, but they are only a starting point in the classification process.

The survey invited respondents to write down questions that "you could ask or could be asked about the security of your system". Therefore, although some questions are clearly ones that the respondents themselves would ask (eg. 'Can I change a user's password for them?'), or would ask themselves (eg. 'Do they really know what a virus is - do they care?'), there are others that would have been addressed to them by other users, for example: 'My password has expired. Can you reinstate?', and some that could fit either category: 'Can I have a document folder that only I can access ...?'.

We can further speculate that some queries may have been rephrased by the respondent, but that they originate from another user's query, for instance: 'Can users' confidential mail be accessed by any

other user ?' may have originated from a question put to the respondent by a less informed user: "Can my confidential mail be accessed by any other user ?' In this instance, the respondent becomes a mediator for the query.

The survey data includes questions formulated as checklist items. These would be questions that a security officer should be asking about the current state of security on the system. In this context, a question such as 'Do you have off site backup ?' does not mean 'Should you have off site backup ?' but 'Check that you do have off site backup'. The checklist style of question is, in fact, a prominent feature of Elbra's security handbook (1992). One respondent has formulated most queries as problem statements (eg. 'The software has terminated due to unauthorised access'), which suggest an implied question ('Faced with this problem, what do I do ?').

Some queries contain several elements which need answering. These range from coordinated questions ('How can I find out how and when ... happened ?'), to appended questions dependent upon the answer to others ('Can viruses travel ... - if so, are there resident checks ... ?'; 'If passwords available, how often are they changed ?'). The 'if' condition, which as noted earlier, is a feature of the sample data, can indicate dependence upon specific circumstances, for example: 'Can users be automatically deleted if they do not sign on for X months ?'

The emerging classification has been outlined below; it reveals the respondent's perspective on the system, which is that of wanting to exercise control

over its various components - the system itself, its users, and external influences which impact upon the system and its security arrangements. The limitations of this classification and observations resulting from it are discussed at the end of this section.

The queries fall into 3 categories, which can be described through generalised questions, as follows:-

1. User's control over the system
"In what ways can I control the system ?"
"In what ways can I control users ?"
2. User's concern over other peoples' control
"In what ways can other people - users or intruders - exercise control ?"
3. User's concern over external factors
"In what ways does security impact upon other aspects of the system and the business and vice versa ?"

1. User's control over the system

The questions which gravitate towards this category express the following needs:

"I need to know ..."

- a. What to do
- b. Whether I can do it
- c. Whether I should do it
- d. Whether I have done it already, it has happened
- e. Whether it will happen
- f. How to do it
- g. When to do it
- h. What it is, how it works and why

i. Why I should or should not do it;
Why it happens or does not happen

a. *Meaning: I need to know WHAT to do in a SPECIFIC SITUATION or in relation to a specific problem*

What happens if I forget my password ?
What happens if the AS/400 ... breaks down ?
What do you do if someone's password expires ?
What do we do if somebody forgets their
password ?

If ..., what do you do in that situation ?
I want to ... What do I do ?

What precautions can be taken to prevent ... ?
What precautions should be taken to preserve
the integrity of the system/ data ?
What regular checks can be made to ensure ... ?
What should happen to the system when the
office is un-manned ?
What is the procedure for setting up the system
security ?

What sort of backups should I be running for my
day to day data ?

Which files should be secured on backups ?
How far back should backups be kept ?

Making sure certain restrictions are made to
access of ...

There are no security arrangements in force -
Where do I start ?

I am not authorised to use the system.
I want authorisation to this system function.

b. Meaning: I need to know WHETHER the system PERMITS ME to do this, or provides these FACILITIES - eg. for security measures, security checks, recovery procedures (specific and general)

Can I change ... ?
Can I restrict access to sensitive files ?
Can you restrict access to ... options ?
Can you restore ... ?
(...) Can you reinstate ?
Can I have a ... that only I can access ?
Can we secure the system against virus attack ?
Can we back up security while people are signed on ?
Can the system itself help me to monitor its own health and safety ?
Can the system help me to monitor infringements and identify vulnerable areas ?
Can passwords be changed ?

Am I able to increase/ decrease security access ?

Is there an audit trail to show ... ?
Is there a way to display ... ?
Is there an easy way to check ... ?
Is there anything on the system an administrator can't find out ?

Are there any checks in software/ data to prevent them being encouraged to "work off the premises" ?
Are virus checkers available ?

Is it possible to check for viruses ?
Is it possible to check the system for
viruses ?
Is it possible to lock the computer screen ?
Is it possible to be completely locked out of
the system ?

If ..., how will I know ?
If ..., how far back does ... remain ... ?
If passwords available, ... ?

What are the rules on ... ?
What security levels are available ?
What flexibility/ options does the system offer
on security ?
What authorization levels do you have ... ?

Does my system support different levels of
security ?

How many security classifications are there ?
How many levels of password are there ?

(...) if so, are there resident checks to
monitor/ ensure the health of incoming data/
mail ?

What can the Security Officer not do ?
How much is there on the system I can't even
see ?
What are the limits of what I can do ?

In relation to users:-

Can I allow users to share ... ?
Can I 'force' users to change their
passwords ... ?

Can I prevent users from leaving ...
signed on ?
Can I look at other peoples' electronic mail ?
Can users be prevented from exiting ... ?
Can users be prevented from signing on ... ?
Can users be given ..., but still ... ?
Can users be automatically deleted if ... ?
Can more than one user have ... ?
Can files ... be locked to prevent updates from
... users ?

Do you have password and user Id's at sign on ?

*c. Meaning: I need to know WHETHER to do this - I am
looking for confirmation or persuasion that this
action or state is a good idea*

Should we restore ... on a regular basis ... to
ensure ... ?
Should I create access authority levels without
consultation ... ?
Should I invoke the automatic password change
facility on our midrange system ?
Should I be using data encryption for
communications traffic ?

When I leave ..., should I sign off ?

Do I have to sign off every time I leave my
computer ?

Must I have access control on my PC - it's such
a pain ?

What are the advantages of group profiles over
authorisation lists ?

In relation to users:-

Should I be allowing users to ... ?

Should users be limited to ... ?

d. Meaning: I need to know WHETHER I have done this (do this) already, WHAT has been done, WHAT has happened

Have IBM default passwords been reviewed ?

Has user access to AS/400 Command line been removed ?

Have any authorisation lists been set up ?

What level of security has the machine been set to ?

What levels of security will I expect to find ... ?

Do security levels for users get checked on a regular basis ?

Are hardcopy reports secured in a safe place when required ?

In the event of a machine crash, do you have a detailed disaster recovery plan ... ?

Do we have physical security ... ?

e. Meaning: I need to know WHETHER this will happen

Will the UPS work when required ?

f. Meaning: I need to know HOW to do this SPECIFIC ACTION

How do I change my password ?

How do I check my present m/cs are virus free ?

How do I shut down a UPS if needed ?

How do I control ... ?

How do you change your password ?
How do you set up a password ?
How do we go about setting up the security ?
How can I find out how and when ... happened ?
How can I prevent ... ?
How can I override ... ?
How can I easily back up ... ?
How can one prevent a virus spreading from ...
to ... ?
How can we best secure the system against ... ?
How can groups ... be set up ?

(If ...,) how can you find extent of
damage ... ?

How do you plan for disaster recovery ?

What ... level ensures a secure system without
reducing ... ?

In relation to users:-

How do I secure ... to specific users ?
How do I restrict user to specific ... only ?
How do you add a new user to the system ?

*g. Meaning: I need to know WHEN to do this SPECIFIC
ACTION on the system*

How frequently should passwords be changed ?
How often should passwords be changed ?
How often should people change their password ?
How often should the security files be backed
up ?
How regular should we be doing our system
backups ?
How many times should a user be allowed ... ?

If ..., how often are they changed ?

What should the back-up frequency be ?

Frequency of backing up system ?

When was ... last backed up ?

For how long can back-up tapes be guaranteed good ?

Can we back up security while people are signed on ?

h. Meaning: I need to understand this FEATURE of the system, WHAT it is, HOW it works and WHY it works that way

What are authorisation lists ?

What is level 40 security ?

What is a group profile ?

What does 'password expired' mean ?

What is the system's resident security rationale, and how do I operate it ?

What is difference in levels or access given by system to ... ?

What is the key ... used for ?

What does the security key position do ... ?

What does the ... system value do ?

What does this red switch do ?

What authority does a particular security level have ?

(...) How do these work ?

What lifespan do backup tapes have ?

Why is spool file security so complex ?

i. Meaning: I need to understand WHY I should do this (this happens), WHY I should not do this (this does not happen)

Why do we need password security ?

Why must I always book the portables out ?

Why do you keep everything locked up ?

Why am I classed as a restricted user ?

Why haven't I got access to all the options in the system ?

Why aren't I allowed to a command line on the AS/400 ?

If you gave me greater access, I wouldn't have to bother you so often (= Why won't you give me greater access ?)

So what's wrong with a couple of illicit copies - no one will know. (= Why won't you let me use illicit copies ?)

2. User's concern over 'other peoples'' control

This typically refers to risk assessment - concerns over potential threats from intruders (eg. hackers) and also from users on the system accessing parts of the system which they do not normally access, with either legal or illegal intent.

"I need to know ..."

- a. Whether people can do this, whether it can happen
- b. How it can happen
- c. What to do if/ in order to
- d. Whether we should do it

- e. Whether we do it
- f. What happens if

a. Meaning: I need to know WHETHER other people or software have access - WHETHER they can do these things, WHETHER the system allows it, WHETHER it can happen

- Can a user have control over ... ?
- Can a user have the same password ... ?
- Can a user sign on ... ?
- Can a user give away objects ... ?
- Can a user "passthrough" ... and gain greater authority ... ?
- Can an individual change their own security level ?
- Can staff inadvertantly destroy ... ?
- Can ... be decrypted ... by potential hackers ?
- Can passwords be found out ... ?
- Can users' ... be accessed by any other user ?
- Can ... be viewed by other users ?
- Can ... be restricted by another user ?
- Can ... be accessed by everyone ?
- Can ... be accessed by other people ?
- Can any user read ... ?
- Can everyone access everyone else's ... ?
- Can 2 users ... pass through without ... ?
- Can other companies access our network ?
- Can other companies use the same network as us ?
- Can ... be secure with ... signon facility available ?
- Can a PC virus be spread ... to other users ... ?
- Can a PC virus destroy ... via ... ?
- Can viruses travel through networks ... ?

Can you use any parts of the system without first having a password and signing on ?

Could a user suppress ... to conceal ... ?

Is my system as secure as possible ?

Are there any ... which a hacker could use to access ... ?

Does anyone have access to all the passwords ?

Do all DP Staff have access to all live environments (any restrictions ...) ?

Do you allow dial in access to your system ... ?

Do you have password security when communicating with 3rd party ?

Is it possible to find out other peoples' passwords ?

Is it possible to get around security ?

Is it possible to break passwords ?

b. Meaning: I need to know HOW software, hardware or people are able to cause intentional or accidental damage - HOW it can happen

How can system security be breached ... ?

How is the system vulnerable ?

How secure is my system ?

How resilient is the system to someone trying to hack their way in ?

How real is the security problem anyway ?

What areas of the system need to be considered in the "system security" light ?

What are the most common ways of breaching security ?

What are the chances of being "hacked" ... ?
What are the potential problems which might
arise when new software is put on to old/
existing data ?

*c. Meaning: I need to know WHAT TO DO IF I detect a
security problem, or IN ORDER TO prevent a problem*

What if I receive messages indicating ...
unauthorised access ?

What practical steps need to be taken to
prevent (hacking)... ?
What is the most practical way to protect ... ?

d. Meaning: I need to know WHETHER we should do this

Should staff who have tendered their
resignations ... be removed from the
system ... ?

e. Meaning: I need to know WHETHER we do this

Are AS/400 History logs being reviewed on a
regular basis to detect unauthorised access
attempts ?

Has any 3rd Party Software ... been reviewed to
check object authorities ... ? - should not be
public access.
Have ... been checked ... ? - should not be
public access.

Do you allow ...; if yes, what security
installed ?

f. Meaning: I need to know WHAT the CONSEQUENCES

might be of this event (WHAT HAPPENS IF)

What problem to security if staff gained
physical access to ... ?

3. User's concern over external factors

These questions are concerned with the interaction
between security and factors 'external' to
security - other parts of the system, the physical
environment, organisational and business issues.

"I need to know ..."

- a. Whether I can do it/ whether it can happen
- b. Whether I should do it/ whether it should happen
- c. Whether we do it already/ whether it happens
- d. How to do it
- e. What happens if
- f. Where we do it
- g. Where I can do it
- h. Who can or should do it
- i. Why it happens

a. *Meaning: I need to know WHETHER I can do this/
WHETHER it can happen*

Is there a check list I could periodically go
through to ensure security and integrity ?

Do you really think 'FAST' will raid us ?

b. *Meaning: I need to know WHETHER we should do this
or WHETHER it should happen - is this a good idea*

Should we set up an internal security audit
function ... ?

Should my system's security ever be audited by a third party ?

Should contracts of employment have a data/software theft clause ?

Is disaster simulation ever a practical way of testing a recovery plan ?

Are all functions within a product necessary ?
(= Should we use all functions ?)

c. Meaning: I need to know WHETHER we do this, WHETHER it happens

Is there a building alarm ... ?

Is computer dept protected by smoke alarm detectors ... ?

Is on site backup stored in secure cabinet ... ?

Do you have off site backup ... ?

Does the computer suite have its own security i.e. limited access ... ?

If ... has windows, are they non breakable ?

If ... activated, is electricity supply ... cut off ?

(UPS batteries) - are they still full of life without faults ?

Have we got long life batteries ?

Do security measures contradict the principles of Total Quality Management ?

d. Meaning: I need to know HOW to do this

How do I discover what products are on the market ?

How do I evaluate these products without prior experience ?

How do I convince colleagues of the need for security if ... ?

How do I persuade them that the ... delay when using security products ... is necessary ?

How do I make staff use non standard passwords ?

How do I stop them storing passwords in obvious places ?

How do I arrange training for over 100 staff ?

How do you educate other users, so they're aware of the dangers ?

How do you encourage them to support existing security practice ?

How do we make sure that everything that should be backed-up, is ?

How can I best persuade staff of the importance of security ?

How comprehensive should a disaster recovery plan be ?

Computer Disaster Recovery - which are the best methods ?

System saves ... need to be done after hours ... this is expensive ... better methods must be found.

Do they really know what a virus is - do they care ? (= How do I explain it to them or persuade them ?)

Which is the best virus protection software ?
(= How do I choose ?)

What organisational procedures should we have
to enhance security ?

What system of backup ... should be used ?

What is the most efficient way of
backing-up ... ?

*e. Meaning: I need to know WHAT the CONSEQUENCES
might be (WHAT HAPPENS IF)*

What impact does comprehensive security have on
response times ?

How quickly will a replacement machine be
supplied if the existing one suffers a major
disaster ... ?

If we expand ..., will it necessitate ...,
which could mean the replacement of all
batteries ?

*f. Meaning: I need to know WHERE we do this
currently*

Where are backups kept ?

g. Meaning: I need to know WHERE can do this

Where do I find info on new viruses ?

h. Meaning: I need to know WHO can or should do this

Who is allowed access to ... ?

Who has access to ... ?

Who should have "security officer" status ?

Who owns the 'master' ... password ?
Is the security officer limited to ... ?

i. Meaning: I need to know WHY this happens

Why won't the Senior Personnel Partner amend
employment contracts to include security as
part of job specs ?
Why won't they tether or bolt PC's to the
desks ?

c. Commentary on intentional and rhetorical analysis

Classification systems are by nature not watertight, so that a number of items will not fit neatly into one category or other. The phenomenon of overlapping or straddling is very well known. There are also specific reasons why certain types of query are difficult to classify with certainty. For instance, in a number of formulations, there is an element of ambiguity, which means that a query taken at face value can belong to more than one category:-

- the pronoun 'you' can refer to the person asking the question or to other users on the system, changing the perspective of control:

'Can you restore deleted objects ?'

can mean

'Can I restore deleted objects ?'

or

'Can users/ hackers restore deleted objects ?'

- the verb 'to have' can mean 'to be given' or 'to take', again changing the perspective of control:

'Can a user have control over his/her own

profile ?'

can mean

'Can I give a user control over his/her own
profile ?'

or

'Can a user take control over his/her own
profile ?'

- the plural noun 'rules' can refer to system rules
or to company rules, as in the example:

'What are the rules on password reuse ?'

can mean

'What are the AS/400 rules on password reuse ?'

or

'What are our company rules on password
reuse ?'

- the passive form 'can be found out' can assume
different agents:

'Can passwords be found out on the system ?'

can mean

'Can I find out passwords on the system ?'

or

'Can users/ hackers find out passwords ?'

The same is true of the formulation 'Is it possible
to ...', which can mean 'Can I ...' or 'Can anyone
...'. The notion of permission or possibility is in
fact strongly ambiguous, as it carries the
suggestion of hesitation; to take one example:

'Can I allow Office users to share a signon
I.D. ?'

can mean

'Is it possible for users to share it ?'

or

'Should I allow users to share it ?'

Other impersonal expressions are also ambiguous:

- 'What happens if I forget ...' can have two meanings:

'What do I do if I forget ... '

or

'What will the consequences be if I forget ...'

- 'Is there an audit trail ...' can mean:

'Does the system automatically provide it ?'

or

'Have we set it up ?'

Elliptical questions are obviously ambiguous, for example:

'Password reuse ?' has several interpretations.

Questions relating to the frequency of an action can conceal that its advisability is also in question, eg. 'How many times should a user be allowed to ... ?' invites the possible answer 'zero times/ not at all', which would then undermine the assumption that the action was permissible, and bring it closer to those questions which focus directly on permissibility ('Can I allow users to ...').

A further problem relates to the time orientation of queries. The vast majority of queries relate to the future, even if from a grammatical point of view

typical future forms are not used. For example, a query which begins with the words "What do we do if ... ?" is almost certainly asking about what action might be taken in particular future circumstances, not about established habits. The only clear exception to this would be the checklist item. This is possible because in English (as indeed in other languages) verb tense and time do not always correspond. The frequent use of the auxiliary "do" (in preference to "will") is additionally interesting because it signals an implicit element of repetition: in the 'microcosm' of computer security, many actions and events have a recurrent nature.

It is worth remarking that when individual queries are listed and analysed, they are taken out of their context. In real life, a query might result from a comment or another query, and it could be interesting and perhaps beneficial to look at larger samples of language with embedded queries. However, a list also reveals something about the relationship of queries to knowledge needs. Two examples from the survey data may serve to illustrate this. In the first, a user has started off with general questions, moved on to highly specific queries, and finished off again with queries of a general nature. In the second, queries have been organised such that they deal firstly with physical security, then data security, communications, and finally, general queries. This suggests that in the minds of at least some users, there are notions of progression and order which could be important in the organisation of information in manuals.

An additional point to be made here is that, again in a real life situation, a query, which typically

springs from doubt or not knowing, may well be imprecise - it will have to be refined by further questioning. As has already been pointed out, some of the queries in the survey data are in fact formulated in two or even (in one case) three parts (eg. joined by the conditional "... if so, ..."; "If ..., and ..., how ... ?").

2. Identification of knowledge types

a. Knowledge need overview

The lexical and terminological analysis allowed us to discover the knowledge needs expressed through the choice of words made by respondents to the survey. Certain concerns surface again and again in the data; these can be summarised as follows:-

TIMING
MANNER
POSSIBILITY
ADVISABILITY
NECESSITY or OBLIGATION

Linked to POSSIBILITY are the concepts of CHANCE or HAZARD, and the notion of CONTROL. CONTRAST, COMPARISON and RESTRICTION were also noted as specific strategies for obtaining knowledge.

Several domains of knowledge were represented in the data, and it became ever clearer that computer security in a business environment cannot be considered in isolation from its closely related - broader, and overlapping - domains, especially business and computing. Computer security was shown to be particularly concerned with people.

The rhetorically-based classification suggested subsequently also makes it possible to see a number of knowledge types in the data. These can be put together to form the overview shown in Fig. 3 (which represents only the "knowledge space" of the data, not all possible permutations).

In brief, the queries about actions and events concern:-

- (a) the ESSENCE (or components) of an action/event
- (b) the TIMING (or frequency) of an action/event
- (c) the MANNER of an action/event
- (d) the LOCATION of an action/event
- (e) the CAUSE of an action/event
- (f) the AGENT/OBJECT of an action/event
- (g) the OCCURRENCE of an action/event
- (h) the POSSIBILITY of an action/event
- (i) the ADVISABILITY of an action/event

Knowledge about ACTIONS and EVENTS - past, present, or future

<----- A C T I O N S ----->		<---- E V E N T S ---->	
(a) Knowing WHAT to do	WHAT happens		
What do I/others do ?	What happens ?		
(b) Knowing WHEN to do sth	WHEN sth happens		
When do I/others do this ?	When does this happen ?		
(c) Knowing HOW to do sth	HOW sth happens		
How do I/others do this ?	How does this happen ?		
(d) Knowing WHERE to do sth	WHERE sth happens		
Where do I/others do this ?	Where does this happen ?		
(e) Knowing WHY to do sth	WHY sth happens		
Why do I/others do this ?	Why does this happen ?		
(f) Knowing WHO does sth	WHO/WHAT is affected		
Who does this ?	Who does this happen to ?		
(g) Knowing WHETHER one DOES sth	WHETHER sth happens		
Do I/others do this ?	Does this happen ?		
(h) Knowing WHETHER one CAN do sth.	WHETHER sth CAN happen		
Can I/others do this ?	Can this happen ?		
(i) Knowing WHETHER one SHOULD do sth	WHETHER sth SHOULD happen		
Should I/others do this ?	Should this happen ?		

Fig. 3 Knowledge need overview

Notes to Fig. 3:

(1) Although the prototypical questions in this scheme imply the prevalent future tense, most questions have the potential to be transformed into the present or past tense, eg. "How do I do this ?" (in future), can become "How am I doing this ?" (currently) or "How have I done this ?" (in the past). The past and present tenses are prevalent in checklist items.

(2) Question types (a)-(f) can each be transformed to add an element of possibility or advisability, eg. "What do I do ?" can become "What CAN I do ?" or "What SHOULD I do ?"

(3) A number of question types can be either reactive or proactive in nature on any given occasion, depending on the structure of the question as a whole, eg. "What do I do if ... ?" (reactive) versus "What do I do to prevent ... ?" (proactive).

b.Dominant question forms and knowledge needs

A frequency count for recurring initial, i.e. capitalised, question forms in the survey data gives us the following picture:

Most frequent verb forms:-

Can
Is/Are
Do/Does
Should

Most frequent interrogative pronouns:-

How
What

The forms "Why", "Where", "When" and "Who" are relatively infrequent. The most frequent forms are used to express the following knowledge needs:-

"HOW"

"How" usually introduces questions concerning MANNER ("How do I do this ?", "How can I do this ?", "How does this happen ?"). It can also introduce TIMING ("How often ... ?"), ESSENCE ("How quickly will ... happen ?"), and POSSIBILITY ("How many levels ... are there ?")

"WHAT"

"What" represents the ESSENCE of an action or event ("What do I do ?", "What can I do ?", "What happens ?", "What happens if ... ?"), POSSIBILITY ("What levels are available ?", TIMING ("What should ... frequency be ?"), MANNER ("What is the system's ... rationale ?", "What is ... used for ?", "What are the ways of ... ?")

"CAN"

"Can" signals questions concerning the POSSIBILITY of an action or event

"SHOULD"

"Should" represents ADVISABILITY

"IS / ARE"

"Is" and "Are" introduce questions which focus on ADVISABILITY, OCCURRENCE, and POSSIBILITY:-

Is disaster simulation ever a practical
.....ADVISABILITY

Is computer dept protected by
.....OCCURRENCE

Is there a Building Alarm
.....OCCURRENCE

Is on site backup stored in secure cabinet
.....OCCURRENCE

Is my system as secure as possible
.....POSSIBILITY

Is there an audit trail to show who
.....POSSIBILITY

Is there a way to display all commands
.....POSSIBILITY

Is there an easy way to check the loss
.....POSSIBILITY

Is there a check list I could periodically
.....POSSIBILITY

Is there anything on the system
.....POSSIBILITY

Is it possible to break passwords
.....POSSIBILITY

Is it possible to check for viruses
.....POSSIBILITY

Is it possible to check the system for
.....POSSIBILITY

Is it possible to lock the computer screen
.....POSSIBILITY

Is it possible to find out other peoples'
.....POSSIBILITY

Is it possible to get around security
.....POSSIBILITY

Is it possible to be completely locked out
.....POSSIBILITY

Are all functions within a product
necessary
.....ADVISABILITY

Are AS400 History logs being reviewed
.....OCCURRENCE

Are there any IBM supplied user ids which
.....POSSIBILITY

Are there any checks in software data
.....POSSIBILITY

"DO / DOES"

"Do" and "Does" introduce ADVISABILITY, OCCURRENCE, POSSIBILITY, and MANNER:-

Do I have to sign off every time I leave
.....ADVISABILITY

Do security measures contradict
.....OCCURRENCE

Do you have off site backup
.....OCCURRENCE

Do you allow dial in access to
.....POSSIBILITY

Do you have password security when
.....POSSIBILITY

Do you have password and user Ids at sign on
.....POSSIBILITY

Do all DP Staff have access to all
.....POSSIBILITY

Do you really think FAST will raid us
.....POSSIBILITY

Do they really know what a virus is
.....MANNER if rephrased

Does my system support different levels
.....POSSIBILITY

Does anyone have access to all
.....POSSIBILITY

Does the computer suite have
.....OCCURRENCE

This means that the most common question forms embrace the following knowledge needs:-

POSSIBILITY	ADVISABILITY	OCCURRENCE
ESSENCE	TIMING	MANNER

A few final remarks about queries. Some queries have an urgency about them, others are to do with long-term planning. Some answers are immediately applied, some are absorbed 'just in case' ("I need to know about this danger, this possible breach, this security procedure in case something happens"). But more fundamentally, queries are "one-off" questions, i.e. the user cannot normally challenge the cooperation of the source (a point made by Blair, 1992, in relation to information retrieval systems in general). Cawsey et al. (1992) also emphasise *belief revision*: users (and information scientists acting as intermediaries) revise their beliefs about what is wanted. An effective knowledge transfer system should take that into account.

3. Source preferences and expectations

Respondents to the survey were asked to express preferences for various sources which they would "turn to for getting information on computer security relating to their system". Table 1 illustrates their choices.

Numbers in the "Blank" column are due to one respondent having indicated a preference for only four of the sources (using preference indicators 1, 2, 10 and 11 - the extremes of the spectrum), and to the fact that some respondents left out "other" (K) as a source. Overall, the figures show that colleagues, manuals, and on-line information are the most preferred sources (in that order), and television programmes the least preferred.

In Section II of the questionnaire, an "expected source of answer" was to be indicated by the respondent against each query. The purpose of this was to find out whether the pattern of overall preferences was the same as in the analysis of the expectations which accompanied the process of specific query formulation. In addition, it was important to see whether manuals occupied an important place in the preference hierarchy, and in expectations. Table 2 shows where users expected to find their answers to queries. The pattern is confirmed, and manuals are shown to occupy an important position - 2nd place - in both tables (preferred sources and expectations).

Order of preference indicated (1-11)

Source	1	2	3	4	5	6	7	8	9	10	11	Blank
A	0	3	4	1	7	7	2	3	5	1	0	1
B	19	3	2	5	1	0	3	0	0	0	0	1
C	0	7	5	7	3	0	3	4	4	0	0	1
D	1	0	0	4	5	8	5	5	2	3	0	1
E	0	1	1	1	4	1	10	7	6	2	0	1
F	0	1	2	3	3	3	5	6	9	1	0	1
G	9	7	7	4	1	3	0	0	2	1	0	0
H	2	10	9	5	1	1	1	2	2	0	0	1
I	0	0	0	0	0	0	1	2	1	21	9	0
J	3	2	3	3	7	10	2	3	1	0	0	0
K	0	0	0	0	1	0	1	1	1	5	16	9

A=books	G>manuals
B=colleagues	H=on-line information
C=external tel.support	I=TV programmes
D=IBM representative	J=training materials
E=Information packs	K=other
F=magazine articles	

Table 1. Preferred sources

B -	89	Colleagues
G -	75	Manuals
H -	36	On-line information
K -	35	Other
C -	26	Telephone support
J -	24	Training materials
? -	18	Don't know
A -	16	Books
F -	9	Magazine articles
E -	7	Information packs
D -	5	IBM representative
I -	0	TV programmes

Table 2. Expected sources of answer

Notes to Table 2:

(1) Although only one "expected source of answer" per query was required, a few respondents gave more than one source, and some gave none.

(2) "Other" sources, where indicated, were "DP manager", "myself", and "intuition".

Chapter V

Knowledge transfer - establishing a mapping

A.General characterisation of the security manual

1.Organisation and readership

The manual "Security Concepts and Planning" (IBM, 1991), begins with a table of contents (7 pages), followed by some introductory notices and remarks (3 pages), 9 chapters (235 pages), 6 appendices (82 pages), a bibliography (2 pages), and an index (28 pages), making a total of some 357 pages. For comparison, a typical published handbook on computer security (eg. Elbra, 1992; Hearnden, 1990) will contain some 200 pages. A word count, sometimes used to indicate corpus size, would not be a meaningful measure in this instance, because there are numerous diagrams, tables, forms, sample programs, and screen displays, where words play a special, sometimes complementary, role in conveying meaning.

Chapters 1 and 2 are an introduction to security, with an overview of controls and an explanation of the main concepts and considerations. The next section covers user profiles. The manual then moves on to resource security, which deals with questions of authority and ownership. Next, there are "security tips and techniques". Chapters 6, 7 and 8, the three longest chapters, cover auditing (monitoring), security recommendations and planning, and setting up security. The final chapter (9) is in the form of questions and answers. This organisation implies a progression from familiarisation with security concepts and the development of an

understanding of risks and considerations, to the implementation and monitoring of security.

Chapter 9, entitled "Security Questions and Answers", deserves special mention here. It contains 21 questions "that are asked most often about security" (pg. 9-1), with an answer for each question. The provenance of these questions is not specified, neither is their sequencing (there may be none). It is interesting to note, however, that 8 of the questions, including the first 6, ask "Why...?"; that there are 5 instances of "How...?" (incl. "if... how...?", "when... how...?") , and 4 instances of "Is there a way...?". Almost half the questions describe a situation of failure or an unexpected event which need to be corrected - questions which might typically be put to a support service, rather than at the stage of planning. Two other questions ask about the consequences or "knock-on" effects of an operation, four about obtaining information of a global nature, while the rest (6) are essentially "how to" questions.

The manual is "intended for someone who is assigned the responsibilities of setting up users and controlling users' authorities on the system" (pg. xiii). It presupposes familiarity with information contained in the "System Operator's Guide", and "New User's Guide". It suggests the use of online help information "to activate and maintain system security" (pg. xiii). It "provides information" about security concepts and planning, making this an informative and expository text which also has defining, enumerative, synoptic, recommendatory and illustrative features. Manuals by their nature are also authoritative publications, even though technical inaccuracies or typographical errors are

bound to occur.

2.Points of entry to the text

Apart from the usual major access devices - table of contents, headings and index - there is much to "catch the eye" of the reader flicking through the manual. Words other than those in headings are sometimes printed in bold (eg. **Note:** ; **Method 1**). Command names (eg. DLTUSRPRF - delete user profile), in capital letters, stand out in the text. Information about security risks and considerations has been placed in boxes which serve to highlight it, and attract attention alongside bullet points, numbered lists, tables, diagrams, flowcharts, screens, programs, and forms.

The index to the manual has 602 main entries (in bold). A large proportion of these are command names, and entry keywords are not unique, eg.

audit
audit log command, display
auditing security

Discounting acronym command names, 31% of main entries (189) relate to distinguishable lexemes, like the 'audit' group in the above example. Nouns (singular and plural), verbs (injunctive form, past and present participles, and one verb in the infinitive form), adjectives, and adverbs all appear in main entries, while prepositions ('for', 'in') can sometimes introduce run-ons. There are specialised terms (eg. 'adopt authority'), semi-specialised (eg. 'display', 'value'), and general language words with a high occurrence in this

context (eg. 'working with', 'using'). There are metalinguistic labels ('definition', 'general description'), and instances of abstract relations ('difference'/'different', 'comparison'). Most items have one page reference only.

B.Summary of retrieval needs and retrieval problems

1.Evaluating the index

The specification of retrieval problems must begin with an evaluation of the index as an access device to knowledge. The relevant British Standard defines an index as: "A systematic arrangement of entries designed to enable users to locate information in a document" (BSI, 1988). The Society of Indexers defines it as "a detailed guide to the information and ideas in a document", which "enables enquirers to find information they need or to recall half-remembered passages", stating that "all good indexes need to be clear, concise, comprehensive and consistent" (Society of Indexers, 1993). According to the Society, the training of index compilers aims to impart a number of skills; these could provide criteria for the evaluation of an index:-

- distinguishing the chief concepts contained in a document
- devising the necessary index terms for those concepts
- dealing with synonyms, homonyms, and related terms
- assessing any need for multiple indexes to the document
- distinguishing between major and minor references
- indicating difference between references to text and illustrations

- preparing copy to a high standard of accuracy

However, although these skills would guarantee a given standard of indexing, the starting point is "the chief concepts contained in a document", whereas we must take the users' discourse as the chief reference point for the evaluation. A different approach would be to try to discover whether look-up operations are successful, i.e. do search terms lead to appropriate locations in the manual ? The main difficulty with this would be that the index can work for one search term/ one query, but not for another - even the use of the same term on two separate occasions can produce results of different degrees of satisfaction - so that a very large volume of test results would be necessary. However, we are concerned with the phase which precedes look-up - finding a search term in the index.

In evaluating the quality of the index, the following stepwise assessment provides a framework:-

- (1) Are the *knowledge needs* from users' queries represented in the index ?
- (2) Are the *lexical items* from users' queries represented in the index ? When a lexical item is not represented, how important is the missing item, in knowledge terms ?
- (3) *How easy is it* to map the language of user queries onto index entries ?

Let us note in passing that the functioning of an

index is determined in no mean measure by the skill, knowledge and intelligence of the user. This is because the user has the power to choose which items to look for in an index, making correct and incorrect choices. A computerised retrieval system can provide automatic search term expansion, but this approach has been criticised, eg. by Ruge (1992) at Siemens Nixdorf, who uses linguistic knowledge for term expansion in the "hyperterm" system REALIST (term modifiers being used to determine degree of semantic similarity between terms) but insists that the user should be the one to choose from proposed "interesting" terms.

Using the above framework for evaluation, an analysis of the index was carried out; this showed the index to be an inadequate access device in several respects.

2. Knowledge needs and problems

a. General considerations

There is an evident yet important point to be made about users' knowledge needs as expressed through their queries and it is this: what users are asking is not necessarily what they should or could be asking ! In other words, there are aspects of security that are not being dealt with by users partly because they are not aware of their existence or importance; conversely, too, queries can be found to be targeting areas of knowledge with, objectively speaking, little pertinence to the domain. This helps to explain why the rich array of knowledge types emerging from an analysis of the domain itself is not reflected in the query data.

Based on the query data, a high level summary of the knowledge needs detailed earlier falls into four areas:

- need for instructions

Briefly, this encompasses "what to do" and "how to do it".

Method, frequency/timing, location, and agent/object may all be required. Specific conditional knowledge may also be needed (restriction/precision).

- need for understanding

For confident and effective security, users need to understand - differences, restrictions, implications or consequences, causes.

- need for advice

This need is focussed on "whether to do". In a domain which has risk at its centre, expert advice is needed on the "best way", and on possibility, necessity, advisability, obligation.

- need for control

Controlling risk means controlling people, resources, and external factors. It transpires in long-term planning, and in more urgent cases - eg. controlling an incident.

The first two categories of needs are less distinctive than the second two. In the learning strategy experiment DIOGENES reported by Ford & Ford

(1992) and referred to in Chapter III, four major categories of question were identified (descriptive, focussing, concrete and analysis); these can all be found in the need for instructions and understanding. The categories of advice and control are a feature of a domain which relates computer resources to the environment; Ford & Ford's experiment concerned the "closed" universe of PRECIS, a document indexing system whose features were being studied in an academic setting.

By contrast with users' global needs, the difficulty of satisfying the needs of individuals, even in a computerised environment, is expressed pointedly by Rex Last:

"...it is relatively easy to design a system which offers a high level of support to the beginner; it is equally straightforward to present a high-powered but more demanding interface to the expert; but what is a far from trivial exercise is to design a system which meets the needs of both, and of others at varying stages of expertise in between, without losing in speed, efficiency, or appropriateness in the level of help and support."

(Last, 1989:82).

According to Ford & Ford, the design of a tutoring system for even one level of user (novice) is a non-trivial undertaking.

b. Content versus knowledge needs

It is important to make clear here by way of example why the widely accepted practice of indexing texts on "content words" fails the user from a knowledge-based perspective. In the first instance, a term like "access" can be described collocationally as a

component of a set of actions and events, as having certain properties, and a comparative dimension ('difference in access', 'greater access') (see Fig. 4). Its meaning is so strongly determined by context, that on its own, it has little meaning. By contrast, the manual's index entry for "access" is a stand-alone term with a mere three sub-entries: "limit to system unit", "PC Support access considerations", and "to display station". For another important term, "password(s)" (the word occurs in nearly 16% of queries), there are ten main index entries of varying length and complexity (eg. "password", "password and user ID journal entries, format for", "password control", etc.), some with sub-headings; however, when one comes to examine users' queries on this topic (see Appendix III for a list), one can see that they represent a wide spectrum of knowledge needs, and that there is currently no mechanism for effecting a mapping from query to index entry.

3. Language needs and problems

a. Discussion of language needs

It is important to resist the temptation to see the language of user queries as being not highly technical and therefore "not special". It is not specialised in the usual sense; however, it is a language variety with a distinctive quality, which can be described by pointing to the preference for certain categories of words: modal auxiliaries, action verbs, nouns referring to method, timing and causation, comparative adjectives and adverbs, pronouns - words which converge on a specific sphere of reference. There is a grammatical distinctiveness

dial in access
limited access
physical access
public access
security access
unauthorised access
user access
access to AS/400 Command
access to commands
access to confidential files
access to live environments
access to menu options
access to passwords
access to sensitive files
access attempts
access authority levels
access control
difference in access
greater access
to create access authority levels
to decrease access
to deny access
to detect unauthorised access attempts
to gain access
to have access
to increase access
to make restrictions to access
to remove access
to restrict access

Fig. 4 Collocational pattern for "access" (n.)

as well as a lexical one. It is only when that specificity is recognised that the language is elevated to at least the same level of importance as the more obviously special language of the manual, and the needs of users can be brought to the fore.

The application environment - eg. business - is a strong influence on this language, reflected not only in the nomenclature but in the overriding concern of wanting to find a "better way" of doing things. This is signalled by formulations seeking to discover "how" (best method) and "when" (optimal time), and questions which suggest decision-making ("can I ?", "should I ?") with a view to improvement. The emphasis on modifiers and modality is striking, to the point where we have to seriously question the widespread tendency to look to more conventional "content" words (usually nouns) for knowledge representation and indexing. Notably, the role of verbs must be fully explored in a domain where the needs for instructions and active control are so clearly visible.

It is not easy to reconcile the user's potentially wavering or fuzzy language, which reflects the process of grappling with incomplete knowledge, with the definitive nature of statements in a manual. From variant spellings, to value-laden words like 'disaster' or 'danger', the user's linguistic repertoire for this occasion is made up of items which blatantly eschew terminological control. Yet somehow these items must be mapped onto the manual's more formal system of representation, bearing in mind that it, too, may not be in a state of perfect terminological control.

Another feature of the user's language is its

orientation towards 'people concepts', which may be contrasted with the manual's system-centredness. This may be an area where knowledge needs depart from what the manual can be expected to provide; on the other hand, it is a challenging case for exploring access paths to knowledge which is in some way present, but implicit or 'hidden'.

It must be said also that certain aspects of the query data analysed raise potential problems for the retrieval of information from a source such as a manual. In particular, there is evidence of variable, unorthodox, or incorrect spelling (eg. sign-on, signon; back-up, backup, back up; id, I.D.; non standard, non breakable; inadvertantly, etc.), and the use of abbreviations (DP, UPS, EDI, info, m/cs, chars etc.). Furthermore, inverted commas have sometimes been used, suggesting an unusual meaning, an element of doubt concerning the correctness of spelling or meaning, or an awareness of special use ("force", "passthrough", "master", "lock").

There is one other issue which underlies all considerations of linguistic expression and mapping. Is it sufficient to smooth the linguistic path to knowledge, or does successful knowledge transfer require an appropriate formulation of the knowledge at the end of that road ? A retrieval aid such as an index can "rewrite" knowledge in the literal sense of using an entry vocabulary consisting of substitute words. A complete rewrite of a manual would be a very substantial, very different undertaking, with wide ranging implications. The 'synoptic rewrite' represented by an index is, above all, a more practical solution.

b.Terminological mapping problems - an illustration

We begin by checking whether the lexical items most frequently occurring in the query data can be found in the index. We have already seen that "access" and "password(s)" are present; "security", "system", "user", "data" and "authority" can be found there, too. Surprisingly, however, "backup" (all spelling variants) is absent; as its importance has already been emphasised, this looks like a major oversight. Admittedly, "saving" and "securing" do cover this concept.

As has been demonstrated, however, although queries contain such terms, much of their knowledge-seeking intention is expressed through other elements. Below are expressions highlighted in two sets of users' queries on the basis that they represent knowledge needs formulated wholly or partly in non-technical language (Appendix IV gives a longer list of such expressions). Against each group of queries is an indication of the index entry in the manual which would be the required entry point. Existence of an index entry does not, of course, guarantee a satisfactory answer to a query. Finding the appropriate index entry (shown underlined) in the first place can be, as illustrated below, a cruelly difficult or futile undertaking.

Example 1

User queries:-

Can more than one user have the same user id ?
Should I allow users to share a signon I.D. ?

Relevant index entry:-

Profile

user

Example 2

User queries:-

How can I prevent someone looking at my document ?
How can I stop someone accessing my office documents ?
How do I give access to only certain documents in a folder ?
Can I have a document folder that only I can access (for confidential work) ?
Can confidential documents be viewed by other users in the output queue ?
How can I be sure no one can access my documents that are confidential ?

Can I "lock" my folder ?
Making sure certain restrictions are made to access of confidential folders.

Can I restrict access to sensitive files ?
I require a user to access parts of a data file via application software, but no access should be allowed via system utilities.

Can users' *confidential mail* be accessed by any other user ?

Can I look at other peoples' *electronic mail* ?

Can *personal mail* be accessed by other people ?

Want to *stop people viewing spool* yet be able to control printers.

For the above group of queries centred around "confidentiality",

confidential	- not in index
sensitive	- not in index
personal	- not in index
electronic	- not in index
mail	- not in index
folder	- not in index
lock	- refers only to keylock switch on control panel

Relevant index entries:-

- document password
- document user profile
- files, logical & physical
- spool control special authority
- spool job user profile
- spool user profile

Conclusions

The philosophical belief that knowledge is allied to language and the evidence that in texts, knowledge is inseparable from language, provided us with a general foundation for the hypothesis that computer users, through their knowledge of language, have some prior knowledge of the domain of computer security and that language can be a facilitating mechanism, or an obstacle, in the development of that knowledge. It also lead to the supposition that users have a conceptual apparatus based on both theoretical knowledge and experience of the world and of domains of special reference related to the environment in which they operate. In this light, both the language of representation in computer security texts and the language of retrieval had to be examined with reference to the representation of knowledge.

We did not have in mind an abstract representation, but one that reflected the perceptions of real people: users, with their needs, and technical writers, with their writing brief. We have to understand *both* knowledge needs *and* the constraints of language on both sides. Then we can start to see what mechanisms are needed to effect successful knowledge transfer. At the same time, it was necessary to draw out the characteristics of the focal domain - computer security - so as to provide an explanation for users' abiding concerns. It is difficult for users to bring to the level of conscious reasoning all aspects of their knowledge needs. Some needs will be elucidated by the nature of the domain (eg. dealing with risk in computer security), others become apparent in elements of language used to express those needs.

If there are recurring concepts in users' queries - which was affirmed by this research with the emergence of concepts like authority, backup, access, password and others - then from the users' point of view, those are the most important. It is for writers to recognise that manuals do not impose a view of a domain. Few are the users who read them from start to finish; and as we have seen, users already have a view, a conceptual structure, which determines what more they want to know. And they already have a language, which determines what they say. Their knowledge is incomplete; the manual can complete it, but in certain respects users know more.

The distinctiveness of our approach resides in the decision to examine the issue of knowledge transfer from the perspective of terminology, but with an equal emphasis on knowledge, and with the user firmly in view. Another notable feature is that retrieval is regarded here as a vital aspect of comprehension, as an important tool in knowledge-building. Put very simply, we are convinced that there is no point in having a perfectly written manual, if the user cannot easily gain access to the section which corresponds to a need. Access to the text is part of the decoding strategy - it should not derange the reader ! The deliberate accent on linguistic ease of retrieval is a challenge to more conventional thinking which focuses on retrieval results. Productivity gains can ensue from the elimination of fruitless searches, and from long-term effective security that comes from better understanding leading to commitment in implementing and maintaining it. Furthermore, the method of data collection adopted, designed to avoid the compromise inherent in queries directed at a specific source,

has allowed us to glimpse an ideal of user need satisfaction against which actual satisfaction in future 'systems' (printed manuals, on-line help, or tutorial modules) can be compared. It has, incidentally, shown that users have different styles of questioning, some organising their thoughts by aspect or level of generality, others defining their needs in terms of problem statements. The progression of questions could be explored further.

The potential danger of dealing with users' needs is that they may be highly diversified. Certainly, users' personal characteristics differ, as do their working environments. A knowledge-oriented approach, however, has allowed us to identify categories of knowledge needs within which variation can still take place. The four global categories distilled from the query data - instructions, understanding, advice and control - provide a framework for future understanding of users' needs in this, and perhaps other domains. The specific knowledge needs identified, ranging from concrete notions of timing, manner, essence, occurrence, location, cause, agent and object, to modal notions of possibility, advisability, necessity, and obligation, provide a catalogue of needs which can be used to guide the creation of appropriate retrieval aids.

In the query data, we have been able to see how access to knowledge is dependent on knowledge of terminology. Conceptual knowledge, expressed in descriptive or 'substitutional' language (pronouns, relative clauses) cannot be used for direct access. We have seen users trying to describe the unknown, succeeding perhaps from their own point of view, but failing from the point of view of the manual, which places specific terminological demands. "The set of

significant words in a text is a fuzzy set" says Charles Meadow (Meadow, 1992:188); users' queries are also an approximation, and again we are forced to consider the implications of Zadeh's fuzzy logic (Zadeh, 1975).

We found that terminological theory was not so well developed that we could immediately proceed to empirical research. Therefore, theoretical deliberations and submissions have constituted a substantial part of this thesis. In laying the theoretical foundations for this research, we were compelled to explore especially the relationship between terms and units or elements of knowledge. This proved a worthwhile undertaking, for we were able to establish that there are many aspects of knowledge - procedural, functional, relational, judgmental, managerial - which are not well served by terms. This conclusion is important, as it leads to the realisation that significant aspects of knowledge could be disregarded or underrepresented in retrieval systems simply because they do not enjoy the "status" of terms. Terminology has a role to play in knowledge ordering, but the expression of knowledge requires concepts corresponding to lexical and grammatical items beyond the class of nouns, and beyond the single word. But first of all, on the simplest level, we must understand and recognise that in the context of retrieval, a "term" like "other peoples' mail" is as good as "confidential mail". With the introduction of the idea of "knowledge need", we have to consider also the intellectual processes of knowledge acquisition, such as comparison. A complete mapping of users' discourse onto the discourse of the manual, for which the methodological principles have been established here, could be the next step, and would

provide further practical pointers for the design of retrieval aids. This could be done on a part of speech basis, eg. starting with mapping users' verbs to nouns.

The characterisation of the important domain of computer security from the two perspectives of knowledge and language, and the description of its specificity, has set a methodological precedent for the analysis of other domains. It was striking and noteworthy to see so many spheres of special knowledge - science and technology, computing, mathematics, security, business, law, language, as well as world knowledge -, and so many knowledge types - 19 in all - represented in what, on the face of it, might appear to be a monolithic domain structure. The fact that users' queries hardly touch some of these fields may be interpreted in several ways: for instance, they may not be aware of these aspects, or they may lack the confidence to probe further, or it could be that the more specific questions which bring in these domains would arise out of actual situations or events, rather than a position of general questioning and planning. On the other hand, the strong presence of some of these domains points to the blurring of boundaries between fields of knowledge. This is important from a theoretical standpoint, and has implications for practice in that technical authors ought to have, and to show in their writing, a greater awareness of 'the world beyond the system', so that the user can be helped to relate special subject knowledge to the operational environment - eg. business.

Not only do domains of knowledge impact upon one another in practice, but their interdependence results from use of a common abstract stratum of

language and from the limitations of word-stock imposing reuse and multiplicity of meanings. Access to knowledge depends on users' linguistic competence: their ability to express their knowledge needs in language, and especially their accuracy (precision) in selecting elements of language and correct graphological form. The linguistic and terminological access problems which have been identified for users 'as a group' can be intensified by individual difficulties. These difficulties will probably remain; we cannot insure either against the inconsistencies and imprecisions of query formulation in natural language as such; however, further work could be done on identifying linguistic differences in users with different levels of experience.

Although we were not seeking to specify in detail what an ideal access mechanism or index might look like, the research carried out allows us to formulate some new and important principles:-

(a) Readers' needs for instructions, understanding, advice and control should be considered prior to the design of appropriate access mechanisms for a given document

(b) Different types of knowledge should be made visible; for instance, where advice is given in the text it should be identified to the reader as being advice (eg. through the use of typographical, graphical or spacial features) both in the text itself and in the index

(c) Abstract notions from the general language (eg. difference, method, rationale, limits, advantages, new/old, comprehensive, unless, while

...) are a significant feature of readers' discourse, as are high level domain concepts (like system, backup, authority, access, personal/public, illegal ...); such items should be included in the index

(d) Users' concern with timing (eg. frequency, reuse, again ...), manner (eg. way, steps, remotely ...), possibility (eg. potential, available ...), advisability (eg. should ...) , and necessity (eg. necessary ...) should be reflected in the index

(e) All parts of speech - not only nouns - are candidates for the index, and should be given consideration during index creation; verbs should be given particular attention

(f) The identification of other domains which have an impact on the comprehension of the main subject field should be carried out to ensure that concepts from those domains are included (eg. business concerns relating to best method, optimal time, decision-making with a view to improvement, 'people concepts' (eg. staff, no one))

(g) The reader will need to be made aware of these novel entry possibilities, i.e. the new indexing principles need to be brought to the reader's attention and explained

(h) The preparation of an index should not be left to the end of a writing project - its compilation will help to determine what should be the content of the document

Seeing that our investigations have put the spotlight on matters of value judgment (advice) and

control (both strategic and tactical), it would be easy to jump to the conclusion that an expert system was what was required. The problems with developing expert systems are many, not least of which is the investment of a great deal of time and resources. However, there may be another way. The text of the manual already harbours much of this knowledge. It is then a question of identifying where in the manual it may be found, and developing the access mechanisms. We know how difficult it is to elicit and represent expert knowledge, but we are only just realising that the communication of expert knowledge to the learner is as difficult, and is perhaps the reason why expert systems have not 'taken off' in the way that was expected. This is where efforts must now be focussed.

There is, of course, the question of whether users will want to turn to textual information when colleagues were found to be by far the most preferred source of knowledge. This would need to be investigated further, to see whether the main factor in this choice was, for example, ease of access, language, or knowledge. In any case, we have also confirmed that retrieval problems are not magically removed by automation. Manuals are still preferred over on-line information. Besides, language-related problems can be amplified if users are not given a chance to exercise their judgment. This is where the conventional 'back of book' index has an advantage: large chunks of it can be viewed at a time and scanned. One of the inherent drawbacks of the index is that it is poised between detail and overview.

Our research has also contributed to the exploration of the problems of ambiguity, highlighting the various interpretations that some questions invite.

We have in some measure managed to 'define the vagueness', capture the uncertainty, of users' discourse, and have grappled with the notion of 'simpler wording', trying to demonstrate that advice on simplification should be more firmly justified and made more specific.

The strategy which was adopted here and which could be generalised for the improvement of technical documentation and its access tools consists of a two-pronged approach: domain and user. If we do not know users' needs, we cannot respond to them; if we do not know the domain, we cannot fully understand users' needs. In the domain of computer security, there is the uncertainty of risk, the repetitiveness of the maintenance of security, the sometimes thorny question of privacy, and so forth. Comparisons between domains must follow, before the specificities of this one can be confirmed, and it would be instructive to see the differences between questions pertaining to the IBM AS/400 system and, say, PC security. Natural language representations of computer security knowledge could also be examined in relation to discourse type, to have a clearer picture of the constraints imposed.

The need for automated training aids is becoming apparent in many domains of knowledge. As has been pointed out all along, documentation is increasingly computer-based, and the possibility of computerised retrieval must always be borne in mind. The problem identification focus adopted in this research does not preclude an electronic implementation of a solution; equally, it has implications for more traditional presentation methods. The issues addressed are of a fundamental nature, spanning epistemology, human communication and learning

theory. The graphic aspect of knowledge transfer systems - incorporating layout and typographic features of texts, and our knowledge of how these features affect learning - is an important one which should not be lost in the race for ever more "glossy" presentation made possible by sophisticated printing and computer display techniques.

The 'back of book' index seems to imply an afterthought. Let us hope that matters of retrieval will be kept at the forefront of documentation designers' minds.

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APPENDIX I

Questionnaire

Note: Originally, it was thought that some of the users to whom the questionnaire was being addressed might be System/36 rather than AS/400 users; in the event, all respondents used the AS/400.

Ref. _____

Aston University Modern Languages Department
Doctoral Research Project

SURVEY OF AS/400 AND S/36 USERS

Questionnaire

This research project is concerned with the way computer users express their information needs. It aims to find out to what extent the language used to express these needs corresponds to the language used in IBM manuals. The results will help to establish how the information contained in technical documentation could be made more easily accessible to users.

We would like to find out what are the questions you have asked in the past, or would now like to ask, about the security of your computer system.

All answers will remain absolutely confidential and will not be associated with your identity at any stage.

Agnes Kukulska-Hulme
Lecturer in Computational
Linguistics

SECTION I

In this section you are asked for some details of your background and present position.

1. Which system do you use ?

AS/400	
S/36	

2. Your present position: are you a 'computer professional' eg. computer manager, systems manager, systems analyst, etc. ?

Yes		Job title
No		Job title

3. What is your previous professional experience ?

(a) in computing

.....

(b) other professional experience

.....

4. How would you rate your knowledge and experience of computers in general ?

Please tick the appropriate box:

1.	very good	
2.	good	
3.	limited	
4.	very limited	
5.	none	

5. How would you rate your knowledge of the IBM AS/400 or S/36 operating system (whichever you use) ?

Please tick the appropriate box:

1.	very good	
2.	good	
3.	limited	
4.	very limited	
5.	none	

6. How would you rate your overall knowledge of computer security in general ?

(We are taking 'computer security' in a broad sense here, to cover all aspects you might care to include, such as physical security, data security, network security, passwords, viruses, and so on.)

Please tick appropriate box:

1.	very good	
2.	good	
3.	limited	
4.	very limited	
5.	none	

7. How would you rate your knowledge of computer security on your system ?

Please tick appropriate box:

1.	very good	
2.	good	
3.	limited	
4.	very limited	
5.	none	

8. Which of the following sources would you turn to for getting information on computer security relating to your system ?

Please indicate order of preference by numbering these from 1 to 11, where 1 = most preferred source

11 = least preferred source

A. books on computer security	
B. colleagues	
C. external telephone support	
D. IBM representative	
E. information packs	
F. magazine articles	
G. IBM manuals on computer security	
H. on-line information	
I. television programmes	
J. training courses and materials	
K. other	

Comments:

SECTION II

In this section, you are asked to write down twenty questions that you could ask or could be asked about the security of your system.

These can be questions you have asked yourself or others in the past, questions that have been put to you, or questions that now occur to you. Try to write them down just as you would spontaneously say them. Assume you can ask anything at all, and do not worry about whether or not the questions can be answered. You can also include questions you already know the answer to, but consider to be relevant.

Your questions can be as general or specific as you like. For instance, you could ask something very general like "Is my system secure?", "What are the precautions I should be taking?", and you can ask very specific questions like "What can I do if someone forgets their password?", "Can I put a user on more than one group list?", etc., or more complex technical questions, depending entirely on your knowledge of computer security. Please indicate the main source where you would expect to find the answer to each question, by entering a letter in the 'expected source of answer' column.

- | | |
|-------------------------------|-------------------------------------|
| A. books on computer security | G. IBM manuals on computer security |
| B. colleagues | H. on-line information |
| C. external telephone support | I. television programmes |
| D. IBM representative | J. training courses & materials |
| E. information packs | K. other (specify) |
| F. magazine articles | ? don't know |

QUESTION	expected source of answer (A-K or ?)
1.	
2.	
3.	
4.	
5.	
6.	

QUESTION	expected source of answer (A-K or ?)
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	

If you have any further comments or information which you think might be relevant, it will be very welcome:

Would you be willing to accept a telephone call if there are any further points I would like to discuss with you ?

Yes	
No	

Thank you very much for your help.

Please send the completed questionnaire to:

Mrs. Agnes Kukulska-Hulme
Modern Languages Department
Aston University
Aston Triangle
Birmingham B4 7ET

APPENDIX II

The following is a copy of the database of respondents' lists of queries (Section II of questionnaire).

- 1 Can I change a user's password for them ?
 - 2 What security levels are available on the system ?
 - 3 Can I allow Office users to share a signon I.D. and have separate passwords ?
 - 4 Should I be allowing users to have more freedom on the system ?
 - 5 Can a user have control over his/her own profile ?
 - 6 Should users be limited to signing on at only one device ?
 - 7 How many times should a user be allowed to try and sign on before the device becomes inactive ?
 - 8 Can a user sign on to the system remotely ?
 - 9 What are the rules on password reuse ?
 - 10 Can a user give away objects that he/she owns ?
 - 11 Is there an "audit trail" to show who has made changes to user profiles, etc. ?
 - 12 Can you restore deleted objects ?
-
- 1 Can I have a document folder that only I can access (for confidential work) ?
 - 2 Can everyone access everyone else's calendar ?
 - 3 Can I look at other peoples' electronic mail ?
 - 4 Is it possible to check the system for viruses ?
 - 5 Is it possible to lock the computer screen ?
 - 6 Do I have to sign off every time I leave my computer ?
 - 7 Can other companies use the same network as us ?
 - 8 How do you change your password ?
 - 9 What do you do if someone's password expires ?
 - 10 How do you add a new user to the system ?
 - 11 Is it possible to find out other peoples' passwords ?
 - 12 Can you use any parts of the system without first having a password and signing on ?
-
- 1 What flexibility/ options does the system offer on security ?
 - 2 How many levels of password are there ?
 - 3 What is the procedure for setting up the system security ?
 - 4 Is it possible to be completely locked out of the system ?
 - 5 If it is, then what do you do in that situation ?
 - 6 What are the most common ways of breaching security ?
 - 7 How can we best secure the system against a virus attack ?
 - 8 What organisational procedures should we have to enhance security ?
 - 9 How often should passwords be changed ?
 - 10 How often should the security files be backed up ?
 - 11 How resilient is the system to someone trying to hack their way in ?
 - 12 What impact does comprehensive security have on response times ?

- 1 Physical security: Is there a Building Alarm and if so is it connected to local Police Station and are key holders informed ?
 - 2 Physical security: Is computer dept protected by smoke alarm detectors and if so are they connected to Fire Station ?
 - 3 Physical security: Does the computer suite have its own security i.e. limited access (key pad security or magnetic card) ?
 - 4 Physical security: If computer suite has windows are they non breakable ?
 - 5 Physical security: If alarm detection activated is electricity supply to computer suite cut off (i.e. air conditioning, computers) ?
 - 6 Data security: Frequency of backing up system ?
 - 7 Data security: Is on site backup stored in secure cabinet i.e. fire/water proof safe ?
 - 8 Data security: Do you have off site backup; if yes, off site frequency and secure cabinet ?
 - 9 Communications: Do you allow dial in access to your system; if yes, what security installed ?
 - 10 Communications: Do you have password security when communicating with 3rd Party (i.e. EDI) ?
 - 11 General: Do you have password and user Id's at sign on ?
 - 12 General: If passwords available, how often are they changed, password reuse, lengths, etc. ?
 - 13 General: What authorisation levels do you have i.e. Library, File, Field ?
 - 14 General: Have IBM default passwords been reviewed on AS/400 and have they been changed ? i.e. QSECOFR
 - 15 General: Has user access to AS/400 Command line been removed ?
 - 16 General: Are AS/400 History logs being reviewed on a regular basis to detect unauthorised access attempts ?
 - 17 General: Has any 3rd Party Software on AS/400 been reviewed to check object authorities of security related commands - should not be public access
 - 18 General: Have IBM object authorities been checked on security related commands, i.e. DSPAUTUSR - should not be public access
 - 19 General: Have authorisation levels been checked on User Profiles (i.e. USER rights or SYSOPR rights, etc.)
 - 20 General: Do all DP Staff have access to all live environments (any restrictions i.e. Payroll) ?
-
- 1 How secure is my system ?
 - 2 Does my system support different levels of security ?
 - 3 What happens if I forget my password ?
 - 4 Can I restrict access to sensitive files ?
 - 5 Can I 'force' users to change their passwords at regular intervals ?
 - 6 Can I prevent users from leaving their workstations signed on ?

- 1 Can a user have the same password twice ?
 - 2 Can passwords be found out on the system ?
 - 3 Can PC Support be secure with automatic signon facility available ?
 - 4 Can users be given access to commands but still be 'limited capability' ?
 - 5 Can users' confidential mail be accessed by any other user ?
 - 6 Can confidential documents be viewed by other users in the output queue ?
 - 7 Can QSECOFR authorities be restricted by another user ?
 - 8 Can a user "passthrough" to another system and gain greater authority than he has on the original system ?
 - 9 Can 2 users on different systems with the same userid pass through without knowing the other user's password ?
 - 10 Can a PC virus be spread via PC Support to other users ?
 - 11 Can a PC virus destroy data on the AS400 via PC Support shared folders ?
 - 12 Can files accessed on PCs via shared folders be locked to prevent updates from unauthorised users ?
 - 13 Can users be prevented from signing on at specific screens ?
 - 14 Can users be prevented from exiting Office Vision to the 'main menu' ?
 - 15 Can users be automatically deleted if they do not sign on for X months ?
 - 16 Is there a way to display all commands, etc. that a user has authority to ?
 - 17 Is there an easy way to check the loss for breaches of authority ?
 - 18 Could a user suppress the 'sign on' information to conceal invalid attempts at signing on ?
 - 19 Can password file be decrypted so that it may be read by potential hackers ?
 - 20 Are there any IBM supplied user ids which a hacker could use to access AS400s ?
-
- 1 How can system security be breached internally ?
 - 2 How can system security be breached from an external source ?
 - 3 What specific precautions can be taken to prevent (1) and (2) ?
 - 4 What regular checks can be made to ensure security is not being breached ?
 - 5 If security files are corrupted, how will I know ?
 - 6 How can I find out how (5) and when (5) happened, and prevent same happening again ?
 - 7 If history file indicates illegal sign-on by users, how far back does history log remain on the system ?
 - 8 If security is breached, how can you find extent of damage (if any) caused ?
 - 9 Should we restore backups on regular basis to ensure they are OK ?

- 1 Can you restrict access to particular menu options ?
 - 2 Can any user read confidential documents ?
 - 3 How do I change password ?
 - 4 Is it possible to break passwords ?
 - 5 When was data last backed up ?
 - 6 Where are backups kept ?
 - 7 What system of backup generations should be used ?
 - 8 What problem to security if staff gained physical access to CPU ?
 - 9 Can staff inadvertently destroy data ?
 - 10 How do I secure library, file or folder to specific users ?
 - 11 How do I restrict user to specific menu only ?
 - 12 What is difference in levels or access given by system by master, security officer, etc. ?
-
- 1 Am I able to increase/ decrease security access ?
 - 2 What if I receive messages indicating outside unauthorised access ?
 - 3 Making sure certain restrictions are made to access of confidential folders.
-
- 1 How do you set up a password ?
 - 2 My password has expired. Can you reinstate ?
 - 3 How do I change my password ?
 - 4 Does anyone have access to all the passwords ?
 - 5 Can folders be accessed by everyone ?
 - 6 Can personal mail be accessed by other people ?
 - 7 Can other companies access our network ?
 - 8 Is it possible to check for viruses ?
 - 9 What is the key on the screen used for ?
 - 10 When I leave my desk should I sign off ?
-
- 1 How many security classifications are there ?
 - 2 How do we go about setting up the security ?
 - 3 Is it possible to get around security ?
 - 4 Can we secure the system against virus attack ?
 - 5 If so, how ?
 - 6 How often should people change their password ?
 - 7 What do we do if somebody forgets their password ?
 - 8 Can we back up security while people are signed on ?
 - 9 Can an individual change their own security level ?
-
- 1 What are the chances of being "hacked" and what practical steps need to be taken to prevent it happening ?
 - 2 How do I convince colleagues of the need for security if solutions involve capital expenditure ?
 - 3 How can one prevent a virus spreading from connected PC's to the AS/400 host ?
 - 4 What should happen to the system when the office is un-manned ?
 - 5 How do we make sure that everything that should be backed-up, is ?
 - 6 What is the most efficient way of backing-up data and software ?

- 7 What should the back-up frequency be ?
 - 8 For how long can back-up tapes be guaranteed good ?
 - 9 Who should have "security officer" status ?
 - 10 How comprehensive should a disaster recovery plan be ?
 - 11 Is disaster simulation ever a practical way of testing a recovery plan ?
 - 12 Should my system's security ever be audited by a third party ?
 - 13 How frequently should passwords be changed ?
 - 14 Should we set up an internal security audit function, eg. using our own computer auditor ?
 - 15 Should staff who have tendered their resignations (3 month period) be removed as users on the system whilst still with us ?
 - 16 Should contracts of employment have a data/software theft clause ?
 - 17 How quickly will a replacement machine be supplied if the existing one suffers a major disaster - IBM lead-times are very long.
 - 18 System saves, etc... need to be done after hours when access is denied to normal users. This is expensive (overtime) - better methods must be found.
 - 19 How real is the security problem anyway ?
 - 20 Do security measures contradict the principles of Total Quality Management ?
-
- 1 Which is the best virus protection software ?
 - 2 Is my system as secure as possible ?
 - 3 How do I shut down a UPS if needed ?
 - 4 UPS batteries - are they still full of life without faults ?
 - 5 Have we got long life batteries ?
 - 6 If we expand IBM, will it necessitate UPS expansion, which could mean the replacement of all batteries ?
 - 7 Will the UPS work when required ?
 - 8 Computer Disaster Recovery - which are the best methods ?
-
- 1 What areas of the system need to be considered in the "system security" light ?
 - 2 How is the system vulnerable ?
 - 3 What precautions should be taken to preserve the integrity of the system/ data ?
 - 4 What is the system's resident security rationale, and how do I operate it ?
 - 5 How do you educate other users, so they're aware of the dangers ?
 - 6 How do you encourage them to support existing security practice ?
 - 7 Can the system itself help me to monitor its own health and safety ?
 - 8 Can the system help me to monitor infringements and identify vulnerable areas ?
 - 9 Where do I find info on new viruses ?
 - 10 How do I check my present m/cs are virus free ?
 - 11 Is there a check list I could periodically go through to ensure security and integrity ?

- 12 Can viruses travel through networks - if so, are there resident checks to monitor/ ensure the health of incoming data/ mail ?
 - 13 Is there anything on the system an administrator can't find out ?
 - 14 What are the potential problems which might arise when new software is put on to old/ existing data ?
 - 15 Are there any checks in software/ data to prevent them being encouraged to "work off the premises" ? - Lotus I know about. How do these work ?
-
- 1 I require a user to access parts of a data file via application software, but no access should be allowed via system utilities.
 - 2 I need to keep a log of all users that access the payroll file via any source.
 - 3 A user is allowed to enter only display commands.
 - 4 I have security officer authority, but I do not want to sign off my screen when I leave it un-attended.
 - 5 Specific users only should be "signed off" if a key depression is not made within 30 seconds.
 - 6 Remote system access must be restricted to office hours only.
 - 7 System termination can only be performed by operations staff.
 - 8 A user password must be greater than 8 digits and contain 3 numbers. The system must control this.
 - 9 I want to know everyones password.
 - 10 I want to limit certain commands to a physical screen location.
-
- 1 There are no security arrangements in force. Where do I start ?
 - 2 How do I discover what products are on the market ?
 - 3 How do I evaluate these products without prior experience ?
 - 4 Are all functions within a product necessary ?
 - 5 How do I arrange training for over 100 staff ?
 - 6 How can I best persuade staff of the importance of security ?
 - 7 Why won't the Senior Personnel Partner amend employment contracts to include security as part of job specs ?
 - 8 Do they really know what a virus is - do they care ?
 - 9 How do I persuade them that the real and perceived delay when using security products during a PC boot is necessary ?
 - 10 How do I make staff use non standard passwords ?
 - 11 Should I create access authority levels without consultation, on the basis of staff grades ?
 - 12 How do I stop them storing passwords in obvious places ?
 - 13 Should I invoke the automatic password change facility on our midrange system ?
 - 14 Why won't they tether or bolt PC's to the desks ?
 - 15 Must I have access control on my PC - it's such a pain ?
 - 16 Why must I always book the portables out ?
 - 17 Why do you keep everything locked up ?

- 18 If you gave me greater access, I wouldn't have to bother you so often.
- 19 Do you really think 'FAST' will raid us ?
- 20 So what's wrong with a couple of illicit copies - no one will know ?

- 1 Can I change my own password ?
- 2 What does 'password expired' mean ?
- 3 Can more than one user have the same password ?
- 4 Can more than one user have the same user id ?
- 5 Why can't I see my password as I key it in ?
- 6 Can you tell me my password ? I have forgotten it.

- 1 Who should be authorized to QSECOFR ?
- 2 How do I ensure that users can access data in files only through the application software ?
- 3 How do I determine which programs use adopted authority (i.e. of the program's owner) ?
- 4 How do I ensure the security of off-line data ?
- 5 What does the 'QSECURITY' system value do ?

- 1 What are the different levels of user security ?
- 2 What system security level ensures a secure system without reducing useability ?
- 3 How can I prevent a user from updating an application's set of files unless they are using the application ?
- 4 Can I put a time-out facility for workstations that haven't been used for a certain amount of time ?
- 5 Can I give a user a command line and then specify which system commands that user has authority to ?

- 1 How often should backups be taken ?
- 2 Which files should be secured on backups ?
- 3 How far back should backups be kept ?
- 4 How often should passwords be changed ?
- 5 Should passwords conform to any standard ?
- 6 Who should have access to passwords ?
- 7 How easy would it be for someone to hack into the system ?
- 8 Do security levels for users get checked on a regular basis ?
- 9 Are hardcopy reports secured in a safe place when required ?

- 1 How often must passwords be changed on the system - has the system value been set up ?
- 2 What level of security has the machine been set to ?
- 3 Have any authorisation lists been set up - if not - how is object authority looked after ?
- 4 Who is allowed access to the QSECOFR password - how often is it changed ?
- 5 Are any remote terminals authorised to the QSECOFR password ?
- 6 If only one terminal was authorised to use QSECOFR, and that terminal was lost, how would you get over this problem ?

- 1 What levels of security will I expect to find and which ones am I authorised to ?
 - 2 How can groups of security levels be set up ?
 - 3 What authority does a particular security level have ?
-
- 1 If the QSECOFR user profile has been disabled is it possible to recover or generate *SECOFR authority some way ?
 - 2 Software viruses are common on PC's, what about on the AS/400 ? Are there virus checkers available ?
 - 3 Regarding remote security, could someone from an outside organisation setup a comms link to our system and signon ?
 - 4 Data saved onto media eg. tape, can this be restored onto another system and manipulated ?
 - 5 In the event of a machine crash, do you have a detailed disaster recovery plan, to cover all your users ?
-
- 1 How do I stop users passing-through to our remote sites ?
 - 2 How do I prevent users from displaying other users reports while they are on the output queue ?
 - 3 Can I prevent users from signing-on during particular times ?
 - 4 How do I give access to only certain documents in a folder ?
 - 5 What sort of backups should I be running for my day to day data ?
 - 6 What are authorisation lists ?
-
- 1 What can I do if I forget my password ?
 - 2 How secure is the AS400 ?
 - 3 Can different users have different security parameters ?
 - 4 Can specific AS400 functions be security protected ?
 - 5 Is it possible to remove the security completely ?
-
- 1 How can I stop someone physically accessing the AS/400 ?
 - 2 Can someone just walk into our environment - sit down & use our system ?
 - 3 Why haven't I got access to all the options in the system ?
 - 4 Why aren't I allowed to a command line on the AS/400 ?
 - 5 Why am I classed as a restricted user ?
 - 6 Can I stop someone viewing a specific file on a system ?
 - 7 What happens if the AS/400 physically breaks down ? Can I return to the same point with the same level of security ?
 - 8 How can I stop someone accessing my office documents ?
 - 9 Why do we need password security ?
-
- 1 How can I access other areas of system ?
 - 2 Can I "lock" my folder ?
 - 3 Can I reduce the security level of my own password ?
 - 4 What are the limits of what I can do ?
 - 5 How much is there on the system I can't even see ?
-
- 1 How do I control who sees what on the system ?
 - 2 How can I see who is trying to access confidential information ?

- 3 How can I prevent someone looking at my document ?
- 4 How can I define security for a group of users ?
- 5 How can I override group security for a particular person to a particular file ?
- 6 How do I stop unauthorised access to a specific application ?
- 7 What is level 40 security ?
- 8 Should I set my system to level 40 security ?
- 9 Can people easily hack into my AS/400 from outside ?
- 10 How can I break the security on the AS/400 ?
- 11 What happens if the security officer forgets the password ?
- 12 What does the security key position do on the AS/400 front panel ?
- 13 Can IBM break our security arrangements ?
- 14 Should I be using data encryption for communications traffic ?
- 15 Can my AS/400 catch a virus ?
- 16 How can I stop the Security Officer or anyone else from viewing my confidential work ?
- 17 Can I see if any external unauthorised users have tried to get into our AS/400 system ?
- 18 How can I easily back up all of my work on the system ?
- 19 What can the Security Officer not do ?
- 20 What lifespan do backup tapes have ?

- 1 How do I get into this function ?
- 2 I am not authorised to use the system.
- 3 I want authorisation to this system function.
- 4 The software has terminated due to unauthorised access.
- 5 How do I enroll a user to use the system ?
- 6 I want to grant a user authority to a group of objects. What do I do ?
- 7 What is an authorisation list ?
- 8 How do I build data base access security into my application ?
- 9 What system functions exist to enable data integrity on the AS400's ?
- 10 What is a group profile ?
- 11 What are the advantages of group profiles over authorisation lists ?

- 1 Is the computer environment secure ?
- 2 Do we have physical security to computer environment ?
- 3 Who owns the 'master'/'security officer' password ?
- 4 Who has access to the security officer password ?
- 5 Is the security officer limited to sign-on at certain terminals ?
- 6 Can I restrict users only signing onto the system once ?
- 7 Can I control the number of chars in their passwords ?
- 8 Are their passwords visible to any other users or are they encrypted ?
- 9 Can I force users to change their passwords every 'X' many days ?
- 10 How can I find if anyone has signed on as the security officer ?

- 11 How can I trace breaches of security ?
- 12 What do I do if someone forgets their password ?
- 13 How do I stop remote users having access to the system ?
- 14 How do I stop users having access to the system libraries ?
- 15 How do I stop users having access to a command line ?
- 16 Can I prevent users displaying spool files for other users ?
- 17 How regular should we be doing our system backups ?
- 18 Can AS/400 shared folders be affected by PC viruses ?
- 19 Can I duplicate the system key ?
- 20 What does this red switch do ?

- 1 What happens if the system goes down ?
- 2 How do I take a backup ?
- 3 Can anyone access my data ?
- 4 Can passwords be changed ?
- 5 If someone leaves how do I stop them accessing the system ?
- 6 How do I guard against unauthorised access via modem ?
- 7 How do I check for viruses ?

- 1 How can I test the systems security ?
- 2 How can I monitor access to secured files ?
- 3 How can I see what an individual has access to ?
- 4 How can I monitor the security officer ?
- 5 How can I prevent the security officer accessing confidential files (i.e. payroll) ?
- 6 How can I deny access to some foreign systems in the network ?
- 7 How can I be sure no one can access my documents that are confidential ?
- 8 What is the most practical way to protect data - by file or by library ?
- 9 Why is spool file security so complex ? Want to stop people viewing spool yet be able to control printers.

- 1 How often should I back up ?
- 2 How often should I change passwords ?
- 3 What should be backed up ?
- 4 What off site arrangements should be made ?
- 5 How do you plan for disaster recovery ?

End of Appendix II

Appendix III

Concordance for "password"

53 questions

Can I change a user's password for them ?
Can I allow Office users to share a signon I.D. and have separate passwords ?
What are the rules on password reuse ?
Can a user have the same password twice ?
Can passwords be found out on the system ?
Can 2 users on different systems with the same userid pass through without knowing the other user's password ?
Can password file be decrypted so that it may be read by potential hackers ?
How do I change password ?
Is it possible to break passwords ?
What happens if I forget my password ?
Can I 'force' users to change their passwords at regular intervals ?
How do you set up a password ?
My password has expired. Can you reinstate ?
How do I change my password ?
Does anyone have access to all the passwords ?
How do you change your password ?
What do you do if someone's password expires ?
Is it possible to find out other peoples' password ?
Can you use any parts of the system without first having a password and signing on ?
How frequently should passwords be changed ?
How often should people change their password ?
What do we do if somebody forgets their password ?
How many levels of password are there ?
How often should passwords be changed ?
Do you have password security when communicating with 3rd Party (i.e. EDI) ?
Do you have password and user Id's at sign on ?
If passwords available, how often are they changed, password reuse, lengths, etc. ?
Have IBM default passwords been reviewed on AS/400 and have they been changed? i.e. QSECOFR
How do I make staff use non standard passwords ?
How do I stop them storing passwords in obvious places ?
Should I invoke the automatic password change facility on our midrange system ?
Can I change my own password ?
What does 'password expired' mean ?
Can more than one user have the same password ?

Why can't I see my password as I key it in ?
Can you tell me my password ? I have forgotten it.
How often should passwords be changed ?
Should passwords conform to any standard ?
Who should have access to passwords ?
How often must passwords be changed on the system - has
the system value been set up ?
Who is allowed access to the QSECOFR password - how
often is it changed ?
Are any remote terminals authorised to the QSECOFR
password ?
What can I do if I forget my password ?
Why do we need password security ?
Can I reduce the security level of my own password ?
What happens if the security officer forgets the
password ?
Who owns the 'master'/'security officer' password ?
Who has access to the security officer password ?
Can I control the number of chars in their passwords ?
Are their passwords visible to any other users or are
they encrypted ?
Can I force users to change their passwords every 'X'
many days ?
Can passwords be changed ?
How often should I change passwords ?

END OF APPENDIX III

APPENDIX IV

Examples of everyday formulations in users' queries.

(This list could be used as test data for an intelligent tutoring system on computer security or natural language retrieval aid.)

more freedom on the system
use the same network as us
to find out other peoples' passwords
most common ways of breaching
how resilient is the system
someone trying to hack their way in
if I forget my password
at regular intervals
have the same password twice
can passwords be found out
viewed by other users
check the loss for breaches
potential hackers
what precautions can be taken
what regular checks can be made
how will I know
how can I find out
find extent of damage caused
to break passwords
where are they kept
go about setting up security
get around security
the chances of being hacked
practical steps taken to prevent
the office is un-manned
a practical way of testing
machine suffers a major disaster
normal users
how real is the problem
as secure as possible
UPS batteries - full of life
will work when required
recovery - best methods
considered in the "system security" light
how is the system vulnerable
security rationale
aware of the dangers
educate users
encourage users
can the system itself help me to
a check list I could go through
travel through networks
the health of incoming mail
an administrator can't find out

problems which might arise
new software is put onto old data
being encouraged to "work off the premises"
I require a user to
when I leave it un-attended
want to know everyone's password
arrange training for staff
persuade staff of the importance of security
security as part of job specs
make staff use passwords
passwords in obvious places
tether or bolt PC's to the desks
more than one user having the same user id
see password as I key it in
how often should backups be taken
how far back should backups be kept
reports secured in a safe place
a machine crash
access to only certain documents
day to day data
remove the security completely
can someone just walk in
return to the same point
other areas of system
the limits of what I can do
I can't even see
who sees what
confidential information
how can I see who is trying to access
prevent someone looking at
what does the security key position do
catch a virus
tried to get into our system
what can security officer not do
get into this function
the advantages of group profiles
visible to any other users
force users to change
how can I find if anyone
stop users having access
doing our backups
how regular
what does this switch do
see what an individual has access to
how can I be sure
most practical way to protect
stop people viewing
how often should I

END OF APPENDIX IV